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THE CADDIS-WORM AND ITS HOUSES.

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(*With a Coloured Plate.*)

Amongst the vast world of animal life which abounds in such profusion in the rivers and ponds of Great Britain, there are few creatures perhaps which will be found more interesting for observation than those insects which dwell at the bottom of the water whilst they exist in the imperfect or larva state. There are some of them which are doubly curious from their inhabiting houses of their own construction, and in which they may be seen walking about at the bottom of ponds or rivers.

At first sight it might seem highly improbable that larvas of any sort of insect should have the faculty of building houses wherein to dwell, but nevertheless it is perfectly true that there are some which have that power given to them, and so well is it employed, that often very beautiful houses are the results of their labour.

The larvæ which form the subject of this memoir, belong to insects of the same order as the dragon flies, namely, the Neuroptera,* and to the family Phryganeidæ. They are more commonly known as caddis-worms.

The bodies of these so-called caddis-worms are, with the exception of their head, very soft; in fact, exactly resembling ordinary meal-worms. They are possessed of six feet, whose uses, as will be presently seen, are employed in more ways than that of merely conveying them from one locality to another. They have also very strong jaws or mandibles, and short antennæ, or feelers. At the end of the last segment or telum is situated two little hooks, which are curved or sharply pointed. These little hooks are strong, and are the chief weapons the larvas employ in guarding their houses for their own use, for by them they are enabled to fasten them-

* In Westwood's *Introduction* they are placed under the order Trichoptera.—Ed.

selves in their houses, and thus resist the attacks of any enemy who may endeavour to pull them forcibly out of their abodes.

These cases or houses, which the caddis so tenaciously guards, are made of different materials, depending upon the locality in which it lives, and also the kind of substances it is able to procure. For instance, if the caddis inhabits still waters, such as ponds where water plants abound, or gently running streams, it will often use the leaves of those plants, and with them most ingeniously make for itself most comfortable and beautiful houses. The leaves are in this case arranged in such a manner that it would seem that not only comfort but also beauty of structure is considered. It is quite a curious sight to see these creatures walking about at the bottom of the water encased in these green portable houses, to which are usually attached a piece of stick or a stone to prevent the caddises and their dwellings from rising to the surface. Sometimes half a dozen may be seen at one time, and in each there is a slight difference of construction, according to the taste and convenience of the worms. It should be perhaps here added, that after the house is completed the head and legs of the larva are the only part which is visible, the rest of the body being always kept encased in its domicile. But these green houses are not the only kinds which are found in still waters. Other kinds may be seen which are made of very small stones, almost as fine as sand, and there are others again which are made up entirely of sticks, their length and size varying much.

In rapid streams, as cases made from leaves of water plants, and stones, so small as those just mentioned, would be speedily swept away by the current, we find that they are built of more solid and heavier kinds of materials. In such streams, if made of stones, the caddis cases are much larger and heavier.

One of the most curious of all the different kinds of houses or cases are those which are entirely made of shells of creatures inhabiting the same stream as the caddis-worms. These cases are frequently found to be constructed of shells of the Planorbis, a small snail, arranged in a most grotesque manner. Frequently the creatures are alive in these shells employed by the caddis in making its house, and then when it walks about it carries the shelled animal, very much to the discomfort of the latter.

Such are the most frequent kind of caddis cases which are found in the rivers and ponds of Great Britain. But it by no means follows that the caddises are incapable of making them from other kinds of materials than those found in the water

where they live. Indeed, they are able to employ various substances, although their capabilities for building are limited to a certain extent in regard to the material and its form. This was found by myself, from experiments tried with the creatures themselves. Having felt extremely interested in watching these caddises walking about with their differently constructed houses at the bottom of the water, I felt an intense desire to find out everything about them.

It was noticed that when the caddis was turned out of its case and placed in a small vessel of water containing the materials with which it was wished to form another, the larva would construct for itself a new house from those materials, provided they were within the limits of its capabilities.

As soon as the caddis-worms find themselves denuded of their houses, they commence forthwith with the materials that may be given to them, and build new ones, never stopping until the greater part of their bodies are encased.

Coloured glass, when broken up into small pieces, makes an extremely pretty case. The colours may be either sorted or mixed, for in either way the case is extremely pretty. With broken pieces of glass the caddis builds very rapidly. In fact, I generally found that cases made from that material were constructed more quickly than when the worm was supplied with other substances. Why this was so I do not know; however, glass is particularly adapted for the caddis to build with. If a case of a better sort of material than glass be desired, it will be found that amethyst or cairngorm will answer the purpose well. But although the caddises are able to construct from either of these sorts of stones, yet I used to observe that when given to them the houses were always much slower in their construction.

Cornelian, agates, and onyx are all capable of being adapted for cases, and look exceedingly well when finished, especially if used separately. A coral house makes a very grand-looking abode for a caddis, but as it is heavy, care should be taken that the pieces be selected from the most slender and thinnest part of a sprig of coral. Pieces of marble broken up into tiny fragments can be successfully employed by the caddis. Shells, mother-of-pearl, when broken into small pieces, or small shells entire, are very quickly made into suitable dwellings by caddises.

I have had cases made from brass shavings, and also from gold and silver leaf. With the two last-named materials the worms experienced considerable difficulty, for they are unable to take up portions separately of gold and silver leaf, and they are obliged to roll themselves up in it in an irregular way.

XUM

Another material capable of being made into a caddis case is coralline. This substance forms a very curious dwelling. I had some constructed from pieces of a kind of coralline when dead, or rather when only the skeleton remained of it. These pieces of this dead or skeleton coralline are blanched, and are put together in such a manner that the case has an appearance as if it had been the work of a basket maker, instead of that of a larva.

But perhaps a more singular-looking case than even these wicker-work ones are those which are made from pieces of tortoiseshell, such as fragments of the teeth of a tortoiseshell comb. If these be given to a worm, it will be seen that it will arrange them crossways. In doing so it will make its house slightly resemble a hedgehog whose bristles are erected. It seems astonishing that there is such a variety of form in the appearances of these different caddis cases. For what can be more unlike each other than cases made from fragments of the teeth of a comb, and that from the pieces of skeleton coralline? What also is more extraordinary, is, that the same worm which can build the basket-looking case can also construct the one resembling a hedgehog when its bristles are erected. In fact, if a caddis is able to make itself a case from any one of the substances already mentioned, it is able to build from all of them. For I have tried their capabilities in that way by giving a caddis a certain kind of material to construct its house, and as soon as it was completed I turned it out, and then give the same worm something different to work upon.

With these new materials it would commence building with as much ease as it did with the former materials, although consisting of a totally different kind of substance from that which it employed in the formation of its previous case.

Although these caddises are so wonderful in being capable of forming cases for themselves of such a variety of structure, yet it is not every substance that they are able to employ for building materials. They are incapable of using anything when existing in a certain form. For instance, although glass is an easy kind of material for a caddis to work with, yet if the form and surface of that glass be smooth and round, as in a small bead, the caddis will be totally unable to make a case from it. In broken glass the pieces are always somewhat angular, and present no difficulty to the worm. Generally, I may state that not only round beads, but every object which is rounded in form and smooth in surface, is unfit for building material, whilst substances with angles and curves are quite fit for the use of a caddis-worm. There are some substances that exhale certain odours, which render them also quite unfit to be used. These scented materials are so highly noxious to the

worms, that they often completely stupefy the creatures, and sometimes even cause their death. If pieces of pine wood be placed in a vessel, and if a caddis be kept amongst that wood, in a short time it becomes stupefied, and would ultimately die if suffered to remain. This stupefaction is caused by the turpentine which is contained in such large quantities in all kinds of pine wood.

Slate is another substance which caddis-worms are unable to employ for their building. I attribute this to a similar cause as that which prevents caddis from using pine wood, namely, the odour. In these cases, however, the substance does not cause any injury to the worms. The same obstacles arise with both coal and brick.

Although there are many kind of metals that can be employed by caddis-worms, yet there are some from which they are quite unable to construct their houses, such, for instance, as lead and copper. I have myself repeatedly endeavoured to get a caddis to use these metals just named, but it was always in vain; although worms would try again and again to build from them, they invariably failed.

It will always be found that if any caddis is not able to construct itself a house from any kind of substance which might be given to it, no other caddis could form a house from the same material. Any number of caddises may be tried for that purpose, yet the results are always the same.

It has before been stated that the weight of caddis cases depends upon the locality that is inhabited by the worms, for it is found that the more rapid the streams, the heavier are the cases.

When a caddis is turned out of its house, the whole surface of its body is covered with air-bubbles. Now, if these creatures are placed under these circumstances in running water, they speedily rise to the surface and float, until at last they die from exhaustion in their struggles to regain the bottom of the water.

This being then the use of the cases to the caddises, let us now see the manner in which they construct them. It is, indeed, an interesting sight to watch them during the progress of their building. The worms commence by placing together a number of pieces of the substances they wish to employ. These are then cemented loosely together, so as to make a foundation for building its subsequent structure. These first pieces that are used as a foundation are always cast off before the completion of the edifice. The cement used by the caddis in fastening the pieces of its house together, is a secretion which proceeds from its mouth. With it the different pieces are fixed together in the most perfect manner. This cement

XUM

answers the same purpose to the caddis-worm as the mortar which is used by the bricklayer in the construction of his buildings. After the foundation has been formed, the caddis proceeds by lifting up with its feet a piece of the material it is employing for its building. This is turned on every side, either in order to discover whether the piece will or will not suit, or else to find out which is the side that will best fit into the space required for it. If the piece is found to answer all the purposes required by the caddis, it is cemented into the space reserved for it by this secretion, which as I have stated before, proceeds from its mouth. If, however, the piece does not suit the space, that piece is instantly rejected, and another one is taken up by the worm in the same manner as the previous one was. Sometimes the caddis is obliged to take up several pieces before it is able to meet with one fit for the purpose. This makes the task of building extremely tedious and laborious. Indeed, with the creature's slender legs it seems marvellous that it is able to take up the different pieces with them, particularly when heavy ones are selected, which is the case when the worms inhabit rough waters. For in those localities the materials are principally large stones, or else thick heavy bits of wood, which must render the building extremely laborious. The building is continued by the caddis in the manner just described without stopping, until it has succeeded in rearing a house according to its taste. When it is completely finished, the whole body of the worm is encased in it, with the exception only of its head and legs, and these even are capable of being drawn into its building, either for its pleasure or for their protection at the appearance of danger.

The caddises are exceedingly fond of the houses which they take so much pains to build, and it is often very troublesome to deprive them of their habitations. They fasten themselves into the end of their houses by the means of those two little hooks which have already been alluded to, and by the aid of which they are enabled to bid defiance to any enemy who might try to denude them of their abodes. When the caddis is once hooked into its case it will often suffer itself to be torn into two rather than allow itself to be dragged out. The obstinate resistance on the part of these caddis-worms often offers some difficulty when it is wished that they should build another case.

But it will be found that caddises will creep out of their cases, if slightly irritated by gently pushing a pin into the end of their case. By this method both case and worm will escape damage and injury.

Now caddises are able to make more than one case for themselves when former ones are destroyed. When I tried

some experiments with them, I found that five was about the greatest number I ever obtained from one caddis. The last one was not nearly so strongly or firmly cemented together as the first one. After the fifth one was made, the caddis, when turned out of it, would invariably bury itself under the heap of the materials given to it without even trying to make another case. It seems that the secretion used for cementing the parts together was entirely used up and failed to be further produced. But although five was found to be the greatest number obtained from one caddis, yet it should be stated that if the worms were captured as soon as they were hatched, and experiments tried with them, I believe they would be able to make more than that number. Frequently they did not succeed in making so many as five cases.

I have seen the small caddises, just hatched, building their tiny houses as early as the beginning of January; of course being then very little creatures, the materials they are only able to employ must be of the smallest description, like sand, etc., for with larger or heavier materials they would not have the strength to take the particles up with their then tiny feet. As they grow so they must enlarge their houses, always building until the creatures cease to grow larger; but in what way they expand the circumference of their dwelling I have not been able at present to observe.

The time taken for a caddis to construct a case varies very much. With some substances a caddis takes more than double the amount of time and labour that it does with others, for with some materials they finish their work in about twenty-four hours, with others again it takes more than a week to do it. It has been already stated, that cases made from broken pieces of glass, jet, shells, or marble, were very much quicker in their construction than when the worms were supplied with either amethyst, or cairngorm, or coral. A shorter time is always taken in the early part of the season, for as the period approaches for the larvas to turn into the pupa state, they require a much longer time to build.

If it be wished to keep caddis-worms for the purpose of watching these creatures constructing their cases, it will be found to be advisable to let each worm have a separate place to work in. They are so extremely quarrelsome towards each other, that if you denude several worms of their houses, and place them together in a vessel of water containing materials for them, you will find that instead of beginning to build they will commence a most deadly warfare with each other, their animosity never being appeased until some one stronger than the rest succeeds in killing them off. After this the survivor will commence his house as if nothing had

XUM

happened. The best way is to let each caddis have a small jar of river water for itself, and which should contain the substance it is wished its house should be built of. The water should be changed daily, so as to let the caddis have always a fresh supply of oxygen, and also to keep the materials bright and clean which it employs.

When the period arrives for these larvas to become pupas they gradually lose their activity, until at last they withdraw their head and legs entirely into their cases, and remain in a completely dormant state for a short time until their last transformation, when they burst open their cases, and rise to the surface of the water in their new and glorious forms of perfect flies. They dry their wings and skim along the surface of the water, their instinct leading them to perform their new career as if they had been accustomed to that state of existence all their lives.

The period in which the transformation from larvas into flies takes place does not always fall at the same time at different parts of the country. In the south of England it generally occurs about the middle of May.

The colour of the fly is brown. It is possessed of four wings, which are equally long, and very much resemble network. Whilst at rest the wings are placed longitudinally. It has also long antennæ. The flies always keep near the water. Their great enemies in all states of their existence are trout, with other fish, who devour them freely; the trout even eat cases and all of the caddis; although they greatly prefer them without the stones and sticks which cover the bodies, as then they consider them exceedingly dainty morsels, and in that condition they are thus found a killing bait by the angler.

But caddis-worms are equally as rapacious as the trout themselves. They have really a tremendous appetite, taking into consideration their size. I have observed that if this was not satisfied they were never sufficiently nourished to be able to undergo their final transformation, but would die whilst existing in the pupa state. When I kept these creatures I used to feed them on pieces of uncooked meat, which they would eagerly seize from my fingers, and ravenously devour. It used to surprise me to see how much such small animals could manage to get through at a meal. They will also eat a common house-fly, the wings, legs, and head being alone rejected as unfit. But meat, if that be cooked, no caddis will offer to touch, however hungry he may be. It is only whilst the caddises are in the larva state that they are so carnivorous. When living in the streams their food consists of the numerous creatures that exist there, as insects, polyps, mollusks, and

they have even the reputation of eating the ova of trout. But after taking into consideration the leathery case and the roundness and smoothness of the ova, and the difficulties which they must present to the caddises, I am inclined to doubt the assertion that they cause in any way their injury. I have placed the ova of trout in the same vessel with caddises, but never knew one to be eaten, and even have known a caddis to incorporate ova into its case. But with the other-named creatures I myself have been an eye-witness of their rapacity. Indeed, as far as the mollusks are concerned, caddis-worms seem to consider them an extremely delicate food, judging from the amount of them they consume when they can get the opportunity to do so. I will here give a little anecdote to prove this, and also to show in what manner I discovered their rapacity in that way.

I had some fresh-water mussels, belonging to the family *Mytilaceæ*, and called the *Dreissena polymorpha*. They were given to me rather as curiosities, and which I kept in an aquarium, containing, amongst other things, caddis-worms. After a short time I found to my mortification a great number of my mussels were dead, as I at first thought, although I was surprised that I never found any trace of the dead creatures, their shells being always open and clean. This state of things went on for a few days, my shells, or rather their inhabitants, vanishing in a most mysterious and unaccountable manner; until one day I saw a caddis walk deliberately up to one of the mussels, whose respiratory orifices were protruded from the partly open shell of the mussel, which was enjoying itself in the nice bright water of my aquarium, not dreaming that there was any danger so near to it.

Well, as soon as the caddis had reached close to the mussel, it seized hold of the siphoned orifices, which are the respiratory orifices of the mussel, and then devoured the poor creature up. Beginning with the part that it first attacked, and continuing its havoc until the shell, or rather the two shells (for mussels are possessed of two shells), were completely emptied. Other caddises were also discovered demolishing others of the same kind of mussel, after a similar manner as that just described.

The mussels which are mentioned here are natives of northern and eastern parts of Europe. They were first discovered in England in 1824, in the Commercial Docks, and have been supposed to have been brought to England amongst some timber. They have been carried to the River Lea, and increased plentifully in the reservoirs and even in the water-pipes of the New River Company in the Green Lanes. By their fertility they have become almost a nuisance, and I may confidently suggest to the New River Company the importation

of caddis-worms into their reservoirs as a means for their extermination.

Now after all that has been stated on the variety of structures of caddis cases, it should be borne in mind that however great may seemingly appear to be the difference between the different cases, such as between the wicker-work house of the caddis and that which was made from the teeth of a tortoise-shell comb, yet the general design of those houses is identically the same. For instance, if they be compared together it will be seen that all the cases are made of the same shape, namely, in that of a tube, and that the same smooth surface is found to exist in the interior of those houses. The only difference between them consists in the manner in which the pieces of the material are arranged, and not in the design of the whole. The design upon which the case is made is derived from instinct, which is implanted into the organization of the creature by nature, which leads them to construct cases of such a uniformity of plan as was said in an analogous case by Gilbert White, in his *Natural History of Selborne*, that "The God of Nature is their secret guide." As soon as the creature is hatched it commences building a house without experience and without knowledge, and without even requiring to be taught, and which is as perfect in its structure as if it had the most extended experience and the most correct knowledge, and the same plan will also be observed in all instances. Instinct then does not proceed from the operations of the mind, but is something which is implanted into the nature of the creatures as a part of their organization, and which causes them to act upon that idea that has been implanted. With respect, however, to the choice of each stone, the caddis is guided by a particular adaptation of each piece for its purpose, and to that extent acts as well as man could do under similar circumstances. Whilst the design of the case is clearly instinctive, as much reason is shown in the choice of materials as man could exercise under the same conditions.

In these pages I have endeavoured to point out simply the principal features of that wonderful instinct which is possessed by the larvæ of that order of insects commonly known as caddis-worms. The facts which I have mentioned were all ascertained by trying experiments with them. For, as I have said at the commencement of this paper, the experiments were carried on solely from an intense desire to know what were the capabilities of these curious creatures. But I feel convinced that more can be learnt of them, and it is in the hope that others may be incited to the same object that this account has been written, which contains that which I myself have learnt through my own observations made upon

creatures obtained from the streams in our garden at Wallington. That it was attended with great amusement I need hardly add. Should any one wish to discover more about them, let them try experiments themselves with these creatures. In the month of April they will find in the rivers the caddis-worms in a most active state, each busily employed in building their differently-formed cases.

Description of Plate.—Fig. 1. Case of a caddis, found in the river where the current is slow. It is built of small stones, attached to a long strip of wood, which balances the weight of the stones. Fig. 2. Case of a caddis found in rough waters. This is much heavier than the former. Fig. 3. Case of a caddis when the larva was turned out of its former one, and was supplied with the teeth of a tortoiseshell comb. Fig. 4. Case as taken out of the river where the stream is moderate. It is formed of the shells of planorbises and shells. Fig. 5. Case made of jet. It should be added the same larva made five cases from this same material. Fig. 6. Case made of the filings of brass. Fig. 7. Case made of sprigs of red and white coral, and will be seen to be a heavy one. Fig. 8. Case made from broken pieces of different-coloured glass. Fig. 9. Case as existing in the river, it consists of small stones and strips of wood, one of which is much longer than the other. Fig. 10. Case of caddis made of silver leaf. Fig. 11. Case of caddis when the larva was supplied with pieces of coralline. It will be seen that the pieces are put together in such a manner that the case bears a great resemblance to basket-work. Fig. 12. Case made when a caddis was supplied with pieces of amethyst. Fig. 13. Caddis case constructed of pieces of cairngorm. Fig. 14. Case made of willow shavings. Fig. 15. Case of a caddis from a gently running stream; it consists of small stones attached to two long sticks. Fig. 16. Case made when the caddis was supplied with red coral. It will be seen that it closely resembles the one which is made of the red and white coral. Fig. 17. Case made of broken pieces of green glass. Fig. 18. Case formed of cornelian. Fig. 19. Case made of broken pieces of shells. Fig. 20. Case from the river, which consists of small stones with one stick attached. Fig. 21. Case of caddis-worm as taken from the river. There is a cherry stone attached to one side of the case. Fig. 22. Case of caddis made of small stones, to which is attached a long strip of wood.

XUM

KEW OBSERVATORY.

It is not always necessary to go to a distance in order to meet with something new, and there are institutions in the midst of us which, from the nature of their work, are comparatively unknown.

Those of our readers who have rambled over the Kew Gardens, or have pleasing recollections of a sail up the Thames on a sultry summer's evening, may perchance have observed, towards Richmond, a building which stands alone in the old Deer Park. Perhaps, also, their curiosity has been aroused by three obelisks, one to the north, and two to the south of the said building, which form a constant source of speculation to the inhabitants of the neighbourhood. These are meridian marks for astronomical instruments, and the building to which they belong was originally the private observatory of George III. Here he spent many of his leisure hours in regarding the heavenly bodies and in other scientific pursuits, while even to this very day reminiscences of the old king linger about the place. The observatory is built on a mound, which raises it somewhat above the level of the park, and is surrounded on all sides by vaults, as an additional precaution against the entrance of moisture from the river. It is not now devoted to astronomy, but the Queen having granted it for the use of the British Association, it is employed by that body for purposes connected with physical science.

Although called the Kew Observatory, the propriety of this appellation is somewhat questionable, since it is really nearer Richmond than Kew; but we all know that it is not easy to change a name.

A committee of the association, men of eminence in science, form the board of directors, and have the power to appoint a superintendent and staff of assistants, who by a wise arrangement are guided rather than trammelled by the supervision of the Board.

The past history of this institution under the British Association is indelibly associated with the names of Ronald and Welsh. The former of these, well known as an electrician, was one of the first to suggest the idea of an electric telegraph. He had also, for a considerable time, instruments of his own construction in operation at Kew observatory for the purpose of ascertaining the electricity of the air, and this branch of knowledge is much indebted to his inquiries.

It is perhaps, however, in his employment of photography for the purpose of recording meteorological phenomena, that he has been of the most signal service to science. Here he was

one of the first in the field, and if his processes have since been improved by Brooke, Welsh, and others, he has at least the credit of first pointing out the capabilities of this wonderful agent. His original barograph is even now in use at the Kew observatory, a similar instrument is in operation at Oxford, and another will shortly be elected at St. Petersburg.

Mr. Ronald was succeeded in his office by Mr. John Welsh, whose untimely death has been much regretted, but who, notwithstanding his short career, left a name well known among magneticians and meteorologists. He was the pioneer in those scientific balloon ascents, which have since been pursued in so indefatigable a manner by Mr. Glaisher, and from the very complete arrangements which he was the means of introducing at Kew for testing barometers and thermometers, as well as from his improvements in magnetical instruments, his name is deservedly known, and his judgment highly respected. But we must now hasten to inform our readers of what goes on at present at the observatory, and even to him whose motto is *cui bono* we hope to demonstrate the use of the institution.

We have already stated that the Kew observatory is physical rather than astronomical, and we may now add that the branches of science to which the labours of the staff have been hitherto most devoted are meteorology, magnetism, and heliography, and these have received an amount of attention which could not easily have been bestowed upon them by any private individual. To begin with meteorology. It was only when the great practical importance of this science first began to be perceived, that accuracy in the construction of barometers and thermometers was at length regarded as absolutely essential to the progress of our knowledge.

It is difficult for any one living in these latter days of accurate inquiry, who has, perhaps, only handled the delicate and exquisite instruments which are now constructed by opticians, to realize the inaccuracy and slovenliness with which the indispensable barometer and thermometer were constructed not a great many years since. We have all heard with a smile of Sir W. Armstrong's village hostess, who was afraid her weather glass was not exactly right, for all the quicksilver had run out of it; but we can hardly believe that twenty years ago many opticians who, perhaps, esteemed the presence of mercury essential to the barometer, yet took little pains to measure accurately the length of column of that fluid. We should also like to know how many observers in those dark days ascertained the temperature of their mercury.

Then again with thermometers. Was the atmospheric pressure always noted when the boiling point of an instrument was marked off by the optician, or could either optician or

XUM

observer give a satisfactory definition of that point? Was either aware of the gradual change which takes place in a thermometer by age; or in graduating an instrument, was any allowance made for the unequal diameter of the bore at different parts of the same tube? These and other questions might well be asked; nor do we err in stating that errors in barometers of that period might often be reckoned by tenths of an inch, errors of thermometers by degrees.

But day was now beginning to dawn, the public were gradually becoming aware of the practical importance of meteorology; the laws of storms (for even storms have laws) were more observed, and while Admiral Fitzroy applied himself to the task of foretelling weather, the Kew committee set themselves to that of improving instruments; for in the peaceful as well as in the warlike arts, one man furbishes the weapon which another man wields.

It was at this stage that the committee were fortunate in securing the valuable co-operation of the late Mr. Welsh as superintendent of the observatory. One of their first acts was to recommend a pattern for barometers to be used at sea, and instruments after their model have since been very extensively employed by Admiral Fitzroy in the department under his control.

Another important point was to obtain at Kew the means of readily determining the errors of meteorological instruments, previous to which it was essential to construct an accurate standard barometer, to which all others might be referred. Let not our readers imagine that this was an easy task, for in order to avoid the influence of capillarity, it was necessary that the internal bore of the tube to be filled with mercury should be at least one inch in diameter. This, after much preliminary difficulty, Mr. Welsh accomplished, by a method which obviated the trouble of boiling the mercury in the tube—in all cases a difficult operation, but with a tube of such a bore nearly impossible.

Having procured their standard of reference, something more was, however, wanting before barometers could be properly tested; no doubt, by suspending instruments in the same room with the standard, the errors of these might be obtained, but only for the existing atmospheric pressure, whatever that might happen to be at the time of comparison. But for marine barometers, with no cistern adjustment, it was essential to know the error at various points, and clearly it would not do to wait for a storm in order to compare together instruments at a low pressure, or for exceptionably fine weather, in order to compare them when the pressure was high.

Evidently the only plan was to obtain the means of pro-

curing at will an artificial atmosphere, which was accomplished by the successful construction of a receiver, with plate-glass windows, into which an additional inch of air might be introduced, or from which three inches might be abstracted. The comparison might thus be made between 31 and 27 inches, a range which comprehends all weathers.

In the next place, with regard to thermometers, the committee undertook to supply all Fellows of the Royal Society, and members of the British Association who chose to incur the necessary expenditure, with standards of their own construction, and such were likewise supplied to the leading opticians, becoming in their hands, as it were, the parents of a host of accurate thermometers. Nor did the labours of the committee end here, for besides thus indirectly supplying the public with a better description of instrument, great facilities were afforded for the verification of all thermometers which might be sent to Kew. By way of variety, let us here give a short sketch of the method employed in constructing a standard thermometer. Our readers are well aware that in every such instrument there are two points which must be accurately determined before graduation, the first of these being the melting point of ice, and the second the boiling point of water.

Let snow or pounded ice be put into a wooden box, and left for some time in a room, the temperature of which is about 32°, and further let the water which forms be allowed to drain off through a few small holes in the bottom of the box. Now introduce your thermometer tube, which had better be an old one, into the mixture, and when it has remained there for some time, make a mark on the tube at the termination of the mercury. This point must denote 32° if you intend making a Fahrenheit thermometer.

But if the melting point of ice be constant, not so the boiling point of water. Were the pressure of the air to fall to 29 inches, water would boil at 210½°; were it to rise to 30½ inches, the same fluid would boil at 213°. The barometer must, therefore, be consulted when the upper point of the tube is marked off, and not only must the bulb, but also the whole column of the instrument up to the termination of the mercury be immersed during the operation in boiling water, or what is better still in the steam which escapes from it into the air.

When you have thus obtained your two points, say 32° and 212° of the capillary bore of your tube be constant throughout, you have only to divide the distance between these into 180 equal parts. But if the bore, as is always the case, be not uniform, you must make your degree longer when it is narrow, and shorter where it is wide; you, therefore,

XUM

require to know the relative diameter of the bore at all the different parts of the tube. In order to obtain this information, a small portion of mercury, sufficient to occupy about half an inch of the bore, is detached from the main body of the fluid in the bulb by a mechanical process, and is made to travel down the tube from the bottom to the top, its length being accurately measured at every stage. Of course where the bore is wide the length of this detached column will be small, and where the bore is narrow, its length will be great. By this method the diameter of the bore is ascertained throughout, and the instrument graduated accordingly.

The result of the labours of the Kew committee was soon apparent. The slovenliness with which meteorological instruments had hitherto been constructed gave place to accuracy, and such are now produced by many opticians with hardly any perceptible error. But here let me impress upon all those who desire perfection not to remain content with the general reputation of the optician whom they employ, but to have their instruments verified at Kew, and a table of corrections procured from that establishment. By doing so, not only is the instrument itself rendered practically equal to a standard, but the optician is kept *up to the mark* by the knowledge that his work is scrutinized. It is now time to notice shortly the various scientific processes which are conducted at the observatory. That meteorological observations are regularly made at Kew, our readers are well aware; and here we may likewise mention the fact that Robinson's anemometer has been improved by Bukly, the mechanic of the observatory, into an instrument which records continuously the direction and velocity of the wind, and which is now extensively adopted. But perhaps the most important processes are those connected with photography. Light plays a very prominent part at Kew. By means of this agent, the changes which take place in the magnetism of our globe, as well as those which take place in the electricity, and the pressure of the atmosphere, are continuously recorded, and, besides all this, the sun is made to take his own likeness.

We cannot here enter into details of construction, let us rather inform our readers what such instruments have already achieved, and what more they may be expected to accomplish. Of the self-recording instruments at Kew the magnetographs are perhaps the most important, and the records of these in the hands of General Sabine have already led to very interesting results. Our readers may be surprised to learn that nothing in nature is more inconstant than the magnetic needle; not only has it a motion depending upon the hour of the day, but it has likewise a change from season to season, and from year to year.

It is influenced by sun and moon, but above all it is subject to sudden and abrupt fluctuations called disturbances, which are invariably accompanied by auroral displays, and by electric currents, which affect our telegraphic wires. The laws which regulate all these motions are best discovered by means of self-recording instruments, and besides investigating these, General Sabine has traced from the records at Kew, and elsewhere, a curious bond of connection between sun spots and magnetic disturbances, two phenomena very unlike each other, but which, nevertheless, have their epochs together.

With regard to the nature of this singular connection we are yet in the dark, but we think the Kew records have thrown some light upon that other bond which links together magnetic disturbances, earth currents and aurora. Men of science abroad are now much alive to the importance of such instruments, and magnetographs similar to those at Kew are already in operation at Lisbon, and will shortly be so in America and Java, in Coimbra, St. Petersburg, and Florence. In illustration of the value of these when all are at work together, we may state that by comparing the Lisbon records with those at Kew, it has already been found that magnetic disturbances break out at precisely the same moment of time in both those places.

We shall now shortly allude to the barograph, another of the self-recording instruments at Kew. By it the changes in the barometer are continuously recorded. Similar instruments are in operation at Oxford and Greenwich, and by means of these it has been found that during sudden squalls the crisis of a storm takes place at Oxford about 50 minutes sooner than at Kew, and at Kew somewhat sooner than at Greenwich. When such instruments are more widely spread, a great increase in our knowledge of storms may surely be expected.

The Kew photoheliograph is already familiar to most of us as the instrument by means of which Mr. Warren Delarue succeeded in obtaining photographs of the sun during the total eclipse which took place in Spain on July 18, 1860, and by which he proved the connection with our luminary of those mysterious red protuberances which are visible on such occasions. The instrument has since been mounted at Kew under the superintendence of this distinguished astronomer, and much curious information with regard to sun spots may be anticipated.

In addition to all this work, monthly observations of the magnetic needle are made in a small building detached from the observatory, so as to be beyond the influence of iron, and scientific men proceeding abroad, with the view of observing the needle at various places, have an opportunity of getting their instruments tested at Kew, and of their receiving instruction in the science of magnetism. By this means we are not only

XUM

brought nearer day by day to that great scientific consummation, a theory of terrestial magnetism, but the practical importance of knowing accurately the behaviour of the needle at the different parts of our globe is patent to every one.

The Kew committee have likewise lately introduced an arrangement by means of which sextants, quadrants, and other geographical instruments may be verified, but we forbear to enter further into this interesting subject at present.

While we have thus imperfectly described the chief processes at Kew we have not even yet exhausted the work of the observatory. As it is an institution for the determination of various points in physical science, new problems of importance are taken up as they present themselves. We have elsewhere noted the fact that Mr. Gassiot's magnificent spectroscope is at Kew, and we shall now conclude by expressing our belief that it will not be allowed to remain idle during the fine summer weather which we hope is near.

THE EARTH AS SEEN FROM THE MOON.

M. Camille Flammarion gives the following account of the appearance the earth must present to the inhabitants of the moon :—

"The inhabitants of the moon perceive in their sky a gigantic star, constantly immoveable at the same height. To their eyes this globe is twelve times as large as the sun, but it differs from all the stars in being always suspended in the same place over their heads. It presents phases to them as the moon does to us, passing through all the gradations of new and full earth. This star, as we have just said, is the earth that we inhabit.

"Those who dwell in the centre of the lunar disc behold our globe suspended from their zenith hovering eternally in the midst of the starry skies. Others see it at 70 degrees of elevation, others at 45 degrees, as they inhabit spots more or less removed from the centre of the visible hemisphere. Those who live near the borders of this hemisphere see our globe on their horizon resting on the mountains. A little further on only half the earth is discernible, and in passing to another hemisphere the view vanishes for ever.

"If we except the determination of longitudes, the earth is more beautiful and more useful to the moon than the moon is to the earth, and if the Selenites* rolling beneath us interpret the law of final causes with as much partiality as we do,

* Selenites, from selene (Σελήνη), the moon, inhabitants of that orb.

they will have a right apparently superior to our own for regarding creation, the earth included, as especially made for the Selenian race.

"The earth is a gigantic globe, sending them thirteen times more light than the full moon transmits to us. It revolves on its axis in twenty-four hours, and during this period exhibits all portions of its surface, being thus more generous than the moon, which always conceals one hemisphere from our view. In consequence of this motion, the Selenite finds himself in an observatory magnificently situated for viewing the terrestrial disc, and his position is preferable to that of the inhabitants of the first four moons of Saturn, who can never see the whole of that planet, and they can see the earth better than we see any planet.

"The earth generally presents to them a greenish hue, in consequence of the immense quantity of water by which its surface is covered, of the forests of the new world, and of its plains, and also on account of the tint of its atmosphere. From time to time, however, large grey or yellow spots divide the sphere. To the east of the terrestrial disc appear the lofty Cordilleras, marked by a long indented line, just as we see in the lunar Carpathians to the west of the Sea of Storms. Opposite this ridge, a shady green spot of great extent unfolds itself for many hours—this is the great ocean. Next come two grey patches, which look like one, elongated; these are the two isles of New Zealand. Then appears the fine continent of Australia, tinted with a thousand colours, and accompanied by New Guinea, Borneo, Java, and the Philippines. At the same time the grey country of Asia is unrolled, and extends to the white steppes of the pole. Africa then comes in view, divided by its milky way of sand. To the north of the great Sahara, appears a little green spot torn in all directions, and full of ramifications—this is the Mediterranean; above which those who have good eyesight will discern little, and almost invisible, France. Then the dry land will disappear, and the great dark spot of the Atlantic will follow the same revolving course. The Selenites who carelessly contemplate in tranquil nights the green and grey divisions of the earth, will have no idea of the contests in which the distant nationalities are involved.

"The earth is a permanent clock to the inhabitants of the moon, and this is not its least utility. By reason of its invariable movements the fixed points which mark the different longitudes will be the hours on the meridian of the moon. Each country of the globe has its peculiar aspect, and may serve for a point of departure. . . . .

"The phases the earth presents to the moon will, in the

same manner, serve as an almanack, and we may believe they form its chief foundation. These phases are complementary to those which the moon presents to us: when it is full moon for us, it is new earth for the Selenites; and when they give us a new moon, we offer them a full earth. No reciprocity can be more perfect and constant.

"But the phases of the earth differ essentially from those of the moon, inasmuch as their intensity, not their magnitude, changes perpetually. This phenomenon is very terrestrial, and we may be sure the Selenites have judged us by it long ago. Whilst with them all is calm, identical, constant, with us everything changes. Besides the different lustre of different parts of the terrestrial sphere, green continents, blue seas, yellow deserts, white poles, and grey lands, our atmosphere is in perpetual commotion. One day it is covered with clouds, and transmits to the moon a uniform white light, the day after it is of limpid transparency, and allows the solar light to fall upon absorbent green surfaces. All of a sudden it will be varied with flocculent mountains, and varied mosaics. Thus the light the Selenites receive from the earth, the light which we call 'ashy,' and which we only perceive in the moon's early days, varies continually in intensity.

"This mobility, this perpetual variation in the aspect of the earth, will have made the Selenites believe that the earth is uninhabited. But on what grounds would they form opinions unfavourable to its habitability? They live on a solid and stable sphere, and can see nothing like it on the earth. Can any rational creature live upon that permanent atmospheric layer which covers all the earth? A Selenite who fell into it would be drowned. Can it be on that sheet of green that washes the greater portion of the earth? Can it be on those clouds that appear and disappear a hundred times a day? And then the earth turns with such velocity; it is subject to so much elemental instability! Moreover, can we believe that its inhabitants are people without weight, preserving, no one knows how, a mean position between the fixed and mobile elements? How can such existences be believed?"

Having thus sketched out the probable effect of the earth upon the Selenites who see it rolling over them, M. Flammarion considers the position of those who live on that lunar hemisphere which we never see, and which never sees us. He distinguishes the Selenites as *Subvolvians* and *Privolvians*,* and points out the totally different kind of beings that may inhabit

* These not very judicious names designate the inhabitants of the two lunar hemispheres, one seeing our globe over their heads, and the other not seeing us at all. In reality it is not a whole hemisphere; but $\frac{3}{4}$ths of the moon that is permanently hid from us.

the two hemispheres, if, as is possible, the one we do not see, possesses water and air. After some other remarks he observes, that the astronomy of the Selenites must appear so complicated as to require the greatest penetration for its true explanation. "They behold themselves motionless in the centre of the universe, they see the sun perform its circuit in $29\frac{1}{2}$ days, and the stars in $27\frac{1}{4}$ days. Those who see the earth will perceive that although it appears almost immoveable in the same part of space, it goes round the sky in 29 days. They would ascribe these movements to the sky and to the earth. As for thinking that they moved, and that this earth was the centre of their movements, and that the sun was the centre of those of the earth and planets; this is a notion to which it would be extremely difficult for them to attain. Celestial appearances are not so complicated as seen from any star as from the satellites."

"Less favoured than the Subvolvian Selenites, who in their transition from day to night pass only from an intense to a feeble light, the Privolvians have a complete night of fifteen days. It follows from experiments of Bouguer, M. Lambert, and even from the theory of Robert Smith, that the mean relation of solar to lunar light is as 300,000 to 1; the mean relation between sun light and full earth light for the Selenites would be as 23,000 to 1. Those who inhabit the opposite hemisphere will have no illumination during their night. But perhaps under their unknown atmosphere they light up artificial suns for half the year; perhaps nature furnishes them with a special illumination, like the Auroras that illuminate our polar regions; perhaps their eyes are constructed for nocturnal life; perhaps they sleep like marmots during their dark winter of half a month. These are all *may bes;* but we cannot doubt that nature has established the Selenites comfortably in their homes; and if one of them came here for the winter he would be astonished with the enormous terrestrial globe that gives us a profusion of day and night, and, like a great child, makes us play at hide and seek all our lives."—*Cosmos.*

XUM

RECENT MICROSCOPIC LITERATURE.*

In the last annual address of the President of the Microscopical Society of London, Mr. Brooke stated, "that no foreign microscope that was exhibited (at the International Exhibition) was at all comparable, either in the convenience of its mechanical or the perfection of its optical arrangements, with the instruments of our best makers." This has been the case pretty uniformly since the application of the achromatic principle to the construction of the microscope; but it is only recently that our opticians have successfully competed with the French in the useful task of giving a serviceable, though second or third-rate instrument, at a low price. At present, it would appear that if optical and mechanical excellence, both carried to the highest degree of perfection, be sought for, they will be found in the workshops of our own great makers; while no foreign artist whose productions we have seen appears to give so much for a little money as can be obtained in the educational and student's microscopes of Smith and Beck, Pillischer, Baker, Parkes, and many others whose names are familiar to all who have paid attention to this branch of manufacturing industry and scientific skill. Almost the only feature in foreign instruments which Mr. Brooke commends to the attention of English makers is the correction of certain objectives for immersion in water, a form of construction in which M. Hartnack, who exhibited in the French Department, excels. Mr. Brooke thus remarks upon these glasses:—"A plate of water should intervene between the objective and the covering-glass of the object. From the increased facility of transmission of the oblique rays through a plate of water, the quantity of light under any given condition of illumination is obviously increased." He adds, "With a $\frac{1}{12}$th objective of moderate angular aperture, which is corrected for immersion in water, I have, I think, in some instances obtained better definition than by any other means." From these remarks it will be seen that the film of water makes a small angled glass work like a larger one, and although there may be some rare occasions in which the plan deserves a preference, it cannot be so generally useful or advisable as that which our opticians have so successfully carried out.

Mr. Brooke expresses himself strongly, as Dr. Carpenter did long ago, on the question of angular aperture, which, he

* *L'Etudiant Micrographe.* Par Arthur Chevallier. Paris: Delahaye.
On Preparing and Mounting Microscopic Objects. By Thomas Davies. Hardwicke.
Quarterly Journal of Microscopical Science. No. xiv. Churchill.

affirms, cannot be pushed to extremes without sacrifice of penetration. We believe Mr. Lister has worked out this subject more completely than any one else, and we think we are right in saying that, omitting mere surface markings of the most troublesome diatoms, rules could be laid down showing the most advantageous proportions in which angular aperture and focal distance should stand to each other to ensure the greatest accuracy of definition. This subject is of great practical importance, and we regret that Mr. Brooke's anniversary address was not more explicit in dealing with it.

The best mode of obtaining great amplification depends in no small degree upon the angle of aperture question. Suppose, for example, a power of 1500 or 3000 linear is required for the exhibition of minute structure. How is it best obtained? Mr. Brooke gives a preference to lengthening the body of the instrument, over the employment of very deep eye-pieces; but upon the subject of deep objectives his statements do not coincide. In his notes on the microscopes of the Exhibition, he tells us that "no objective yet manufactured for sale at all rivals in its power of development the $\frac{1}{25}$th of Messrs. Powell and Lealand," and in the presidential address we find the contradictory assertion that he "has not hitherto succeeded in developing any point of organic structure with Powell's $\frac{1}{25}$th that is not equally visible with $\frac{1}{12}$th by Ross." If $\frac{1}{12}$th of Ross and $\frac{1}{25}$th of Powell and Lealand were selected as of equal merit in workmanship, it would still be found that they differed considerably in the proportion which their angles of aperture bore to their focal lengths; and it is difficult to believe that the two proportions are equally advantageous. Messrs. Powell and Lealand's exquisite $\frac{1}{25}$th is much more limited in its range of utility than their $\frac{1}{12}$th, because the latter will work through thick covering glass, while the former requires it to be so extremely thin as scarcely to bear a touch. Messrs. Smith and Beck's $\frac{1}{20}$th, which has a moderate angle of aperture, is as generally applicable as a $\frac{1}{12}$th or a $\frac{1}{8}$th; and this constitutes no small proportion of its merit. Mr. Ross's $\frac{1}{12}$th, as stated in his catalogue, has an angular aperture of 170°. Working angles of aperture are nearly always *much* less than those calculated by opticians; but suppose Mr. Ross made a $\frac{1}{20}$th of the same working angle, or less than that of his $\frac{1}{12}$th, it does not seem possible that when used to obtain the same amplification, they should both be equally advantageous in point of penetration. We have tried and admired Ross's $\frac{1}{12}$th, and that of Powell and Lealand; but when it is desired to see the interior structure and movements of small objects, such as desmids or infusoria, it cannot be a matter of indifference whether a given magnification is obtained by a deep objective of moderate angle,

XUM

without the draw-tube, and with a first eye-piece, or with a lower objective of actually larger angle, with a deeper eye-piece, or with a few inches of draw-tube.

We have heard an experienced microscopist speak as Mr. Brooke does in one of his conflicting remarks, that he could see all with his $\frac{1}{12}$th that he could see with his $\frac{1}{25}$th; but it appears to us that this question wants carefully working out with especial regard to penetrating power. When an object—other than diatom lines—has been seen with a $\frac{1}{8}$th or $\frac{1}{12}$th, can it not nearly always be shown by $\frac{1}{5}$th? A good $\frac{1}{5}$th will work well up 700 or 800 or 1000 linear, and most things that can be seen with 2000 linear can be made out with half that power when their existence is known.

We are abandoning excessive angles of aperture in this country, and the Americans are resorting to them. This will give rise to inquiry as to the value of their observations, and when such observations necessarily require penetration, accompanied by fine definition, we should be disposed to doubt the correctness of the appearances brought out by objectives in which the angle of aperture was very large in proportion to focal length.

So long as microscopic students are merely engaged in laying the foundation for original inquiry it may be doubted whether they will do any good with a magnification of more than 500 linear, but when original inquiry begins, high powers become indispensable, and the best mode of obtaining them is an important consideration, on which we should recommend new and careful experiments to be made.

Passing from points which experienced microscopists are alone qualified to discuss, we come to subjects of more general interest, and congratulate Mr. Davies on the aid he has afforded to microscopic students by his compact work on preparing and mounting microscopic objects. His book is necessarily and avowedly in the main a compilation, but the reader has also the advantage of the author's personal experience, and will derive much information, not only with respect to different methods of mounting, but likewise concerning the treatment which particular objects require. The instruction ranges over a wide field, comprehending diatoms, desmids, sections of organic and mineral substances, anatomical preparations, dissections, etc., and the directions are given in a clear, agreeable style.

In mounting objects it is customary to use Canada balsam thinned with spirits of turpentine or camphine; but it is often desirable to obtain the resinous matter in a more liquid and volatile solution. One good plan is to dissolve thick balsam in wood naphtha, or pyroligneous ether, which is by far the best

solvent for cleaning slides. Another plan is to use chloroform, as Mr. Davies thus describes:—"The balsam is exposed to heat until on cooling it assumes a glassy appearance; it is then dissolved in pure chloroform until it becomes of the consistence of thick varnish. This liquid is very convenient in some cases, as air bubbles are much more easily got rid of than when undiluted Canada balsam is used. It also dries readily."

We shall make one more extract from Mr. Davies, relating to the treatment of the Equisetaceæ, which are now growing in easily accessible places. He is speaking of their preparation for the polariscope, and tells us, "Some of these plants, including many of the grasses and Equisetaceæ (*i.e.*, horsetails), contain so large a quantity of silica, that when the vegetable and other perishable parts are removed, a skeleton of wonderful perfection remains. This skeleton must be mounted in balsam, the method of preparing which will now be considered."

"Sometimes the outside of the Equisetum is removed from the plant, others dry the stem under pressure, whilst the grasses of course require no preparation. The vegetable should be immersed in strong nitric acid, and boiled for a short time; an effervescence will go on as the alkalies are being removed, and when this has ceased more acid should be added. At this point the modes of treatment differ; some remove the object from the acid, and wash, and having dried, burn it upon thin glass until all appears *white*, when it must be carefully mounted in balsam. I think, however, it is better to leave it in strong acid until all the substances, except the required portion, is removed; but this will take a length of time, varying according to the mass, etc., of the plant. Of course, when this latter method is used, the skeleton must be washed from the acid, etc., before being mounted in balsam."

M. Chevallier's book is an effort, on a smaller scale and less comprehensive plan, to do for French students what Dr. Carpenter's work on the microscope has accomplished for our own. From his pages we conclude that many desirable accessories for the illumination of both opaque and transparent objects that are commonly employed in England are little used in France, and the chapter on Test Objects, mainly founded on experiments so old as those of Dr. Goring, would not in this country be considered up to date. The student is taught, for example, to be satisfied with a definition of the Podura scale, far below what would be given by a fair second-rate quarter-inch of English make.

M. Chevallier recommends distilling a liquid from Canada balsam, in order to obtain a fluid well adapted to thin other specimens of the balsam, or to soak objects in, that are intended to be mounted in it. He likewise recommends a

XUM

varnish made by dissolving copal in essential oil of lavender. A drop of this varnish is placed on the slide, the object laid on it, covered with thin glass, and set aside in a warm place for a few days. Another varnish, which he affirms to give excellent results, is composed of—

Canada balsam	30	grammes.
Tears of mastic, powdered .	10	„
Chloroform in sufficient quantity.		

The chapters on preparing objects are very good, but most of the information is the same as that given in Mr. Davies's work. M. Chevallier, as the latest contribution to this subject, gives the following process, modified from that prepared by Mr. Leader of Philadelphia. He says, "I have lately tried a new compound which has given very good results, with Naviculæ and other delicate objects. Here is the formula:—In 30 grammes of chloroform dissolve 1 gramme of caoutchouc. When the solution is effected, add tears of mastic until a syrupy or demi-syrupy consistence is obtained." The object is put in a drop of this solution on a slide, gently pressed and allowed a day to dry, after which the edges of the covering glass are varnished. It is said to be perfectly transparent and unalterable.

Before leaving the subject of mounting, we must allude to Mr. Freestone's new mounting-table, described by Mr. Goddard in the *Quarterly Journal of Microscopic Science* for April, 1864, p. 45. The object of Mr. Freestone's invention is to dry and harden slides rapidly, without injury to the objects.

"It consists of a plate of brass 12 inches by 3, and one-eighth of an inch thick. Upon this, two pieces of metal of the same thickness, and 12 inches by 1, are riveted, leaving a clear space one inch wide in the centre of the plate; the whole being supported on tubular legs seven or eight inches high." The slides are laid across this table, which is heated by a spirit lamp underneath, and from the form of the table the part of the slide containing the object does not touch the brass plate, but is heated by conduction, radiation, and by currents of hot air. Mr. Goddard states that delicate sea-weeds, such as Plocamium and Cladophora, can be mounted in balsam by the aid of this apparatus without losing their colour.

We do not observe in M. Chevallier's work many allusions to articles of apparatus not well known in this country; but the "variable objective" invented by his father we have not had an opportunity of seeing, and, from the description, it might be very handy. "It is composed of two brass tubes sliding one in the other; and at the extremity of each tube is an achromatic lens of long focus. . . By means of the

sliding tube, the two links may be separated or approximated so as to give a greater or smaller magnification."

M. Chevallier's work is, in many respects, well executed; but we regret that in describing the Infusoria he follows the classification of Müller, according to which rotifiers are confounded with the vorticellids, because both make whirlpools by means of their cilia, a fact not quite true of the floscularians, and which, taken by itself, affords little clue to either affinities or structure.

EXOGENOUS SEEDS AND FERN SPORES.*

BY R. DAWSON, M.B., LONDON.

(*With a Tinted Plate.*)

BALFOUR, in his *Manual of Botany*, says, "The embryo varies in its structure in different divisions of the vegetable kingdom. In Acrogenous and Thallogenous plants it continues as a cell or spore, with granular matter in its interior, *without any separation of parts or the production of cotyledons.* Hence these plants are called Acotyledonous."

Further on he says, "The spore of Acotyledonous plants is a cellular body, from which a new plant is produced. Germination takes place *in any part of its surface*, and *not from fixed points.*"

Moore, on *British Ferns*, defines spores much the same; describing the determined points in seeds, the cotyledons, the ascending and descending axes, and then, contrasting the development of ferns' spores, says, "On the contrary, they consist merely of a small vesicle of cellular tissue, growing *indifferently* from any part of its surface" (*Hand-book of British Ferns*). Carpenter on the *Microscope*, Lindley's *Vegetable Kingdom*, etc., all have a like idea. The above, then, is the received opinion of the present day relating to the growth of the fern spore. See also Hofmeister's elaborate work, published by the Ray Society.

These same high authorities also state and believe that ferns germinate by bodies called antherozoids or males, coming into connection with archegonia or females, and this occurs on the first-formed body from the spores, called prothallium.

The first part of these statements, as far as I can learn, has never been questioned; the latter has, though now universally accepted. I proceed to disprove the first statement entirely, and I hope to throw discredit on the last.

A seed in its simplest form, such as seen in the mistletoe,

* This paper was read before the Brighton and Sussex Natural History Society.

XUM

is composed of a cell called a nucleus, within which is the germinal sac, containing the germinal vesicle. In the amniotic fluid, attached to the germ sac, is the suspensor. If the mature germ fill merely its sac, the rest of the nucleus is filled with vegetable albumen (see Campanulaceæ), or the germ may fill both its sac and nucleus (see Compositæ).

Now this germ sac is formed by a depression at the apex of the nucleus, the edges meeting; but at the point where they meet is the spot where the future root will make its first appearance. Whatever coverings may grow over the seed, they avoid this spot, which, in time, becomes a little hole, and called the foramen or micropyle, marking the organic apex of the nucleus. The organic base is marked by the chalaza, where are seen fibro-vascular bundles passing forwards from the funis or umbilical cord to the nucleus.

The hilum marks where the funis joins the seed to the placenta.

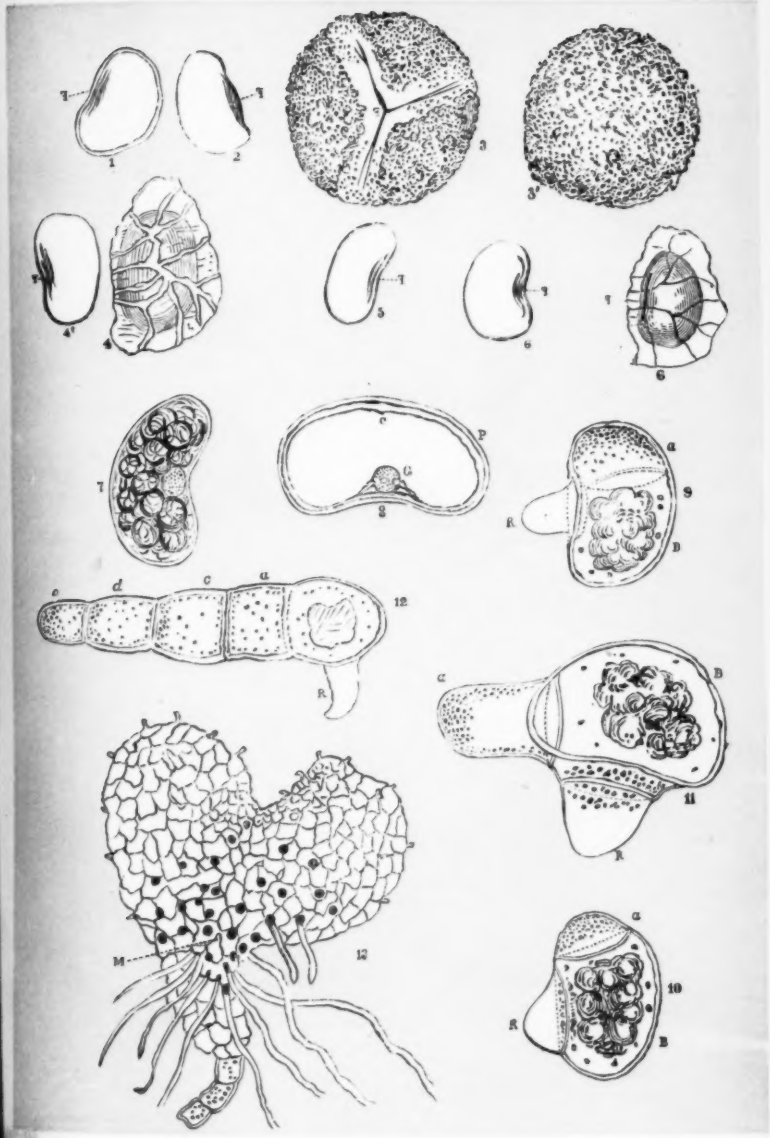
The nucleus may simply be an erect ovule, when the base will correspond with the hilum, or it may make a procession till the apex comes down to the hilum, or may retain any intermediate position. Moreover, the nutrient matter may make a bend on itself, in which case the seed will be said to be camptotropal or curved like a horse-shoe.

Around the nucleus may be coverings, called intine and extine, being developed from its base. Moreover, it may have another covering, as in the mace or spindle-tree, called an arillus, developed from the chalaza or from around the foramen.

A perfect seed, therefore, consists of a nucleus, a germ, and a germ sac, which latter contains the embryo of an ascending and descending axis, together with nutrient matter, having a foramen of exit and certain coverings.

When a seed begins to grow, having imbibed water, the radix pushes forward through the foramen, and if the coats of the seed be thin, they rupture irregularly from the pressure, so that, at first sight, it would seem as though there were no foramen. While the radix pushes its way out, the nutrient matter within has been undergoing changes: starch becomes, through diastase, dextrine and grape sugar. Meanwhile the germinal spot has arranged itself, and the plumule or ascending axis can be traced; the nutrient matter supplying sustenance to the several parts, as in wheat or barley; or else it forms itself into primary leaves, as in the bean or mustard, not having enough matter in itself entirely to nourish the plumule. Therefore these leaves elaborate matter taken from the ground by the radix, and so indirectly support it.

If the spores of ferns be carefully examined, there will



GERMINATION OF FERN SPORES.

1. Spores of Lastræa dilatata. 2. Spores of L. filix-mas.
3. Osmunda regalis. 3' Back of same. 4. Polypodium phegopteris. 4'. When young.
5. Platycerium alcicorne, and 7, 8, 9, to 13. 6. Lastræa rigida.
6'. The same young. 7 to 13. Progressive development of Platycerium alcicorne.
A. First new cell. B. Old cell. C. Primary vesicle and germ.
F. Foramen. R. Radia. P. Extine. M. Fern always appears here.

XUM

be seen on all markings, such as seen in Plate (Figs. 1 to 7). What are these markings?

If a spore be examined when young and transparent (Fig. 8, *Platycerium alcycorne*), it will be noticed that there is an outer covering and an inner lining membrane filled with clear homogeneous matter, and invariably, near the marking above named, a compound body in a sac; attached to the sides of which, proceeding from the marking to the body, are two small processes if the body be in the centre of the marking, but one, if it be to the side. If the mature spore of the same plant be examined, it will be found, as at Fig. 7, filled with a mass of yellow refractive globules, and the nucleus will with difficulty be made out; but if some reagents, such as glycerine, be added, the globules will become transparent, and the nucleus revealed again. These globules are the homogeneous matter before named, plus other matter imbibed. If a mature spore be grown and watched from time to time, the following results:—The spore swells, at the marking before named a peculiar body appears (R, Fig. 9). This pushes its way through the marking, as seen by the dotted lines, and so the cell is ruptured. This marking proves itself to be a vaginal opening, or, in other words, a foramen (F), and the body which has pushed out, a radix. While this change has been going on, a corresponding alteration has ensued within the spore. At the upper part a cluster (A) of green bodies has appeared precisely similar to those seen afterwards in all the cells of the prothallium, while the globules of matter have shrunk into a mass (E) not large enough now to fill the cell (B). Meanwhile the cells at A have constituted themselves into a new cell (C), excluding B; C takes another cell (D), and this again another, and so on till a body of the form of Fig. 13 is formed, which is called the prothallium. While A has been undergoing these changes, B's matter has wasted entirely away; a few cells, such as seen in A, are within it, but its future destiny is not absolutely traced.

For convenience I will name all these described parts. The spore is a nucleus with a covering; it contains a germinal vesicle in a sac. The opening in the spore covering is the foramen. When the spore grows, the radix forces open the foramen, while the primary germ has been undergoing a change. This reads very like the description of a seed; and the similitude does not merely extend to appearance, but the functions of both are alike. The only difficulty is in the prothallium, which appears, at first sight, to have no analogy in the seed, though, in fact, the cotyledons in the mustard and the prothallium in the fern are identical, answering the purpose of developing the plumule. I have hitherto, as far as

XUM

possible, avoided this word cotyledon, and have used nutrient matter, for it signifies not what the form of the matter, its function is the same, viz., directly to nourish the radix, directly and indirectly to nourish the plumule. Now, in the wheat it simply supplies nourishment to both till it is exhausted, being sufficient, all things being equal, to develop the young plant till it is able to gain its own sustenance. But in the mustard it is the reverse; there the nutrient matter is not sufficient to support the radix and plumule entirely, so it changes itself into leaves, whereby matter taken up by the radix may go to the support of the plumule; and this is proved by seeing the leaves in full vigour, when the plumule can scarce be traced. Moreover, when the plumule is once established, these leaves waste and die, or, if they be plucked off, the plumule will not appear. Now the proof that this matter in the spore nucleus is nutrient, is seen in its wasting in proportion as the radix and primary cell develop, during all which time those cells which have to develop into the future fern are quite rudimentary, and not traced for a certainty as yet. Now the mustard cotyledons are only the rudiments of the two cotyledonary leaves, for it can be seen that these latter grow. But the prothallium is but an elaboration of the cell (A), derived from the nutrient matter (B). The question is one, therefore, only of degree; and if mustard has one or more cotyledons, the spore must have the same. We need no fanciful resemblances, or else, to look at the prothallium, we could imagine two cotyledons in one. I have said that a seed has a suspensor; I have pointed out bodies attached to the primary vesicle of a like kind. Moreover, seeds have an arillus or extra covering. Figs. 4 and 6 show a covering around many kinds of spores. 4' 6' mark the appearance of young spores of the same kind, showing that, at one stage of existence, the spore has not this covering; in fact, every intermediate stage may be seen.

It can be clearly demonstrated that, at the point F, which marks the foramen, the hilum also exists; but the analogy between a seed and a spore is, I think, sufficiently perfect. What have I done then? I have made my fern to partake of the nature of a flowering plant minus the flower. And now one word as to *filicial sponsalia*. Where is the marriage-bed?

Flowers have an infancy and manhood, and in this last proper time they generate their species. Flowers are not peculiar, animals do the same; in fact, save in one solitary case, throughout animated nature, no individual is said to beget its offspring before its own proper self has any existence. Incredible as it may seem, one plant is believed by all scientific men to-day, to be begotten, to have all its own offspring

pre-begotten and pre-destined, before that solitary individual has made its appearance or *de facto*, is—and that one plant a Fern.

Sumniski and Mercklin affirm, and men believe them, that on the prothallium, before the fern has any being, two bodies exist, male and female; that the males, enclosed in their own proper envelope, live in cells, which from time to time burst, setting free their occupants, which are individuals with a club-head, like a spermatozoa, a spiral tail, and six cilia at the head; that the females are small pyramids of cells, having at the bases the germinal spot, at the apex an opening; that the males enter the pyramids, and passing down a straight tube, effect the conjunction required; that from this spot the future fern grows, already pre-destined and pre-impregnated for the years or ages of its life.

The story is too romantic, the compromise between animal and vegetable impregnation too obvious to be real; besides, what are the cilia and curved tail for, impediments rather than aids to going down a straight tube, and cilia are for swimming, but where has the Leander to swim to his Hero? Moreover, these so-called males and females are not a few, but many, at the base of the prothallium, to the right and left of the centre line —how strange that never more than one female becomes impregnated, and that only one fern results from so much generative matter, and on one prothallium. Again, how strange that this fern which does result, occurs in the middle line invariably, and never to the sides, although females are as many at the sides as middle. I have carefully observed these bodies, which are clearly to a demonstration nothing but roots and stomata in all stages of development; that by the pressure of the covering-glass the contents of the young ones may escape, but that they have tails and whiskers is pure imagination. These same bodies may be seen clearly in the radix from the very outset, and have nothing whatever to do with impregnation; at a future time I will illustrate this more fully. For the present, however, ferns are still Cryptogamia, and their conjunction to be found out; but we have one aid furnished us by this inquiry, a spore is a seed, a seed came from an adult plant, nor was it formed on a cotyledon-placenta. We must look, then, to the adult fern for its two elements, and there we find evidence enough for demonstration.

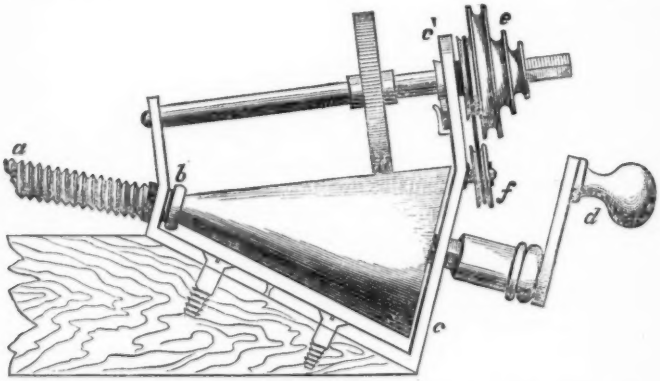
I have omitted to note the form of the fern ovule: if what is affirmed be true, the cotyledon must be curved on the germ. The foramen and hilum corresponding, we shall, therefore, have a camptotropal ovule. In another paper, I hope to give sufficient evidence of the impregnation of adult ferns, and that occurring where the fruit is found.

XUM

STAR FOLLOWING.

BY REV. E. L. BERTHON, M.A.

In the Intellectual Observer for May (No. xxviii. p. 290), a description is given of convenient methods of following the heavenly bodies in their apparent courses, with a telescope mounted on a new table-stand; but as the woodcut necessary to make it intelligible was accidentally omitted, the object of these few lines is to supply that deficiency; and the accompanying illustration is to be understood as belonging to that description.



The reader is also requested to refer to the Intellectual Observer for November, 1863, No. xxii. p. 283, for a drawing and specification of the stand, to which these recent improvements are added.

The writer further embraces this opportunity of offering a few remarks upon the advantages of good stands for astronomical telescopes.

Although equatoreals are becoming daily more common, they will never, for obvious reasons, entirely supersede those possessing horizontal and vertical motions; and to combine these two movements together to produce an even course without vibrations, or a succession of jerks, is a considerable step in the improvement of table-stands and in increasing the effectiveness of the optical instrument so mounted, and the comfort enjoyed in its use.

The two chief desiderata in a stand are—

1st. That it be steady and free from vibrations.

2nd. That the least possible exertion be required to set and

keep it in motion, for in the more delicate observations the observer is often sadly distracted by his efforts, owing to the imperfection of his stand, to keep the object steadily in the centre of the field of view.

It has been remarked by eminent astronomers, that an inferior telescope on a good stand will do more than the best instrument badly mounted; that recommended by the inventor in this and the previous articles, combines the advantages of great steadiness and comfort in use in a high degree. It will be observed that the forces which produce motion both in azimuth and altitude are exerted on the *base* of the stand, and that the tube is never touched; there is, therefore, as little proportional tendency to shake it as there would be to shake a tree by applying force to its roots, instead of seizing its branches. Besides, the telescope is not held by one joint only, but it is actually supported on four trunnions, the long side-arms doing duty as bearers as well as steadying-rods.

Although this construction may not be adopted for sale by opticians as being less portable, and not so easily packed in a case as the pillar-and-claw stand, it will be found very delightful to amateurs, who, if possessed of a little mechanical skill, and with the aid of a joiner and tinman, may erect one for a small sum. The tripod stand for out-of-door service is very much used, but it is not a comfortable arrangement, especially in any of the more delicate observations; if the astronomer stand up he finds it difficult to keep his head steady, and to sit down in the open air is not always pleasant in a winter night.

Mr. Bird in the last number of the Intellectual Observer, p. 242, remarking upon the almost necessity of comfort to the observer, if he would make anything of minute details in the Stellar or Planetary Orbs, says, "To do any of these things effectively in the open air, with one's telescope agitated by the passing wind and a body shivering with cold, is clearly next to impossible."

The strong recommendation of this gentleman, who has done so much with silvered specula, that amateurs should provide themselves and their instruments with the genial shelter of a cheap observatory, cannot be followed too soon or too generally; but the writer, having the same end in view, hopes that the above-named very intelligent astronomer will pardon him for stating that though cheap, his is not the *cheapest* observatory, he (the writer) having himself erected one for half the money, which he most strongly recommends to the consideration of all amateurs who possess a garden or other ground with tolerable sky-view; it is extremely pretty both externally and internally, and forms a most pleasing ornament to a garden

or pleasure ground. It was built last summer, and answers admirably, being 10 feet clear in diameter inside, and 10 feet 6 inches high to the apex of its roof, which is conical and opens to every part of the sky, from the horizon to the zenith.

Although Mr. Bird's observatory cost certainly very little, £14, that possessed by the writer cost him less than £6, and it might be built anywhere for £7. As the luxury of such a pleasing retreat to the student of the noble science of astronomy is immense, it is presumed that many a shivering *dilettante* would be glad to possess one if put in the way to obtain it for so small a sum. The writer, therefore, would be happy to publish, in a future number of the INTELLECTUAL OBSERVER, if agreeable to the editor, a full description of a cheap and ornamental observatory, such as any village carpenter could build in about a fortnight.

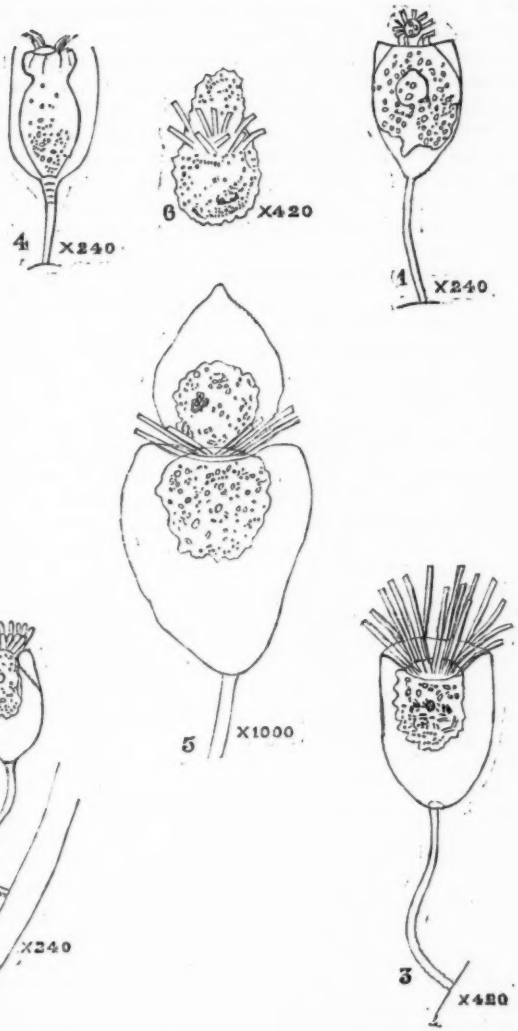
A SUPPOSED NEW ACINETA.

BY HENRY J. SLACK, F.G.S.,

Member of the Microscopical Society of London.

(*With an Illustration.*)

ON the 22nd April I spent a couple of hours at Budleigh Salterton, South Devon. At this little place the Otter enters the sea, forming, for so small a stream, a somewhat large estuary, which low water reduces to a mud flat, through which the river runs in one principal and some subsidiary channels, the latter, no doubt, subject to much variation. At the time of my visit, one of these little channels, a few feet to the west of the principal one, was full of seaweeds, on which I noticed diatoms growing. A tuft of fine weed, covered with Synedræ, was put into a bottle, and on examination disclosed a number of Cothurniæ, or creatures resembling Vorticellids, but inhabiting elegant glass-like cups, supported on stalks. One of these is shown in Fig. 1. These, although very pretty objects, did not detain my attention, as I had often seen them before; but I was surprised to find in other cups, not in any way to be distinguished from those in which Cothurniæ were living, a creature differing from anything I had previously met with. My first impression, on seeing a row of cylindrical and stiff tentacles, was that I had found a small polyzoon; but, on viewing it with a higher power, I saw that the tentacles were not ciliated, and I could not discern a trace of internal organs proper to so high a group. Polyps the animals certainly were not, and my puzzle increased. The Cothurnian lives in his cup



EXPLANATION OF PLATE.—Fig. 1. Cothurnian, mag. 240. The horizontal lines at the top of the stalk not seen in all specimens. Fig. 2. Supposed new Acineta, mag. 240. Fig. 3. Another specimen, with tentacles extended, mag. 420. Fig. 4. Another specimen, the sarcode exhibiting apparent remains of a tailfoot. The circle with three dots represents a small boss of sarcode, with three tentacles fore-shortened, mag. 240. Fig. 5. Two individuals, in conjunction (?), mag. 1000. Fig. 6. The sarcode of the above, showing tentacles in two rows, mag. 420.

XUM

or bottle in an intelligible way. He stands upon a footstalk, or tailfoot, and jumps up and down as he likes. The new creatures were, on the contrary, suspended near the mouth, as shown in Fig. 2. The cups of the Cothurnians, and of their strange companions, were so transparent, so clean, and so thin near the edges, that their rims wanted careful illumination to make out, and I did not succeed in determining *precisely* how the new creatures were moored. In favourable specimens I saw two delicate lines, as in Fig. 2, which did not, with any power or illumination, look like cords; but which I supposed represented a very fine membrane going all round the animal's body, and probably forming an inversion of the cup rim. The animals were very sluggish; but occasionally the group of tentacles would be retracted, though not perfectly. In this state they were like a row of regular teeth. Slowly they were protruded, generally not more than in Fig. 2, but in one specimen, as fully as Fig. 3, which is drawn on a larger scale. I looked in vain for positive organs in the little granular lump of sarcode that formed the body. At first I thought I made out a contractile vesicle; but I could see no regular expansion and contraction. The sarcode mass varied in details in different individuals. In some, large granules and vacuoles were discernible; in others, both granules and vacuoles were small. Most of them, in shape of body, resembled Figs. 2 and 3, and did not occupy more of the cup. One, however, departed from this rule in two particulars; first, his body was large, and, at the hinder part, was what might be taken for the remains of a tailfoot: secondly, instead of a simple row of tentacles, he had some perched on a boss of sarcode, as shown in Fig. 4, where the dots represent three tentacles fore-shortened.

Another case presented a still more curious peculiarity, as shown in Figs. 5 and 6. There was nothing to determine what the two portions were about. It could scarcely have been fission, because the larger and smaller portions were each in a separate cup or bottle, the upper one having no stalk. Was it conjunction? I do not know. I watched them for about three hours, then checked the evaporation of the water drop under the thin glass cover, by running a little wax from a *vesta* round the edges, and in the morning found the situation unchanged, but the animals apparently dead. In this case the tentacles were in two rows, one apparently belonging to each portion of the compound object.

Small infusoria frequently bobbed against the tentacles, and sometimes large ones; but the creatures remained very sluggish, and made no attempt to capture prey. Jarring the table, suddenly pressing the glass, produced no effect; nor did shifting the cover glass, by moving it laterally with considerable

roughness. On one occasion, a Euplotes, who seemed tormented by the adhesion of foreign bodies, and by some disorder that produced bumps on his surface, made use of one of the new creatures as a sort of rubbing post. This went on for some minutes without disturbing its repose, but at length the tentacles did retract.

I was strongly impressed with the idea that the creatures were transition forms, and could not conceive that the stalked cups were made by them in anything like their present condition, or that they were ever made by and for an inmate who was destined to remain suspended from their mouths, leaving the greater part of the space waste. I thought they were transition forms of the Cothurnians, and still think so, although I could find no positive proof of the correctness of this view. In some Cothurnians, the edges of the cups were prolonged, and in Fig. 4 the new animal filled the cup better than any others which I saw, and it had something like the remains of a tailfoot.

The new creatures varied considerably in size, the most common dimensions being about 1-100″ from the top of the expanded tentacles to the bottom of the footstalk. The stalks were curved, or straight, indifferently, as were those of the Cothurnians. The normal form was, I suppose, straight, and the curvatures accidental.

I have called these objects new, because I cannot find that anything exactly like them has been previously described; but the creatures seen by Mr. Alder in 1851 seem to have been in *some respects* similar, judging from his sketches; though they have been treated as if they differed widely from mine. Mr. Alder's account was published in the Transactions of the Tyneside Naturalists' Field Club, and from thence transferred to the *Annals of Natural History*, 1851, vol. vii., p. 426. His words are as follows: "While examining a specimen of Sertularia taken from the rocks at Whitburn, under the microscope, I was struck with the appearance of what seemed a very minute parasitic Zoophyte, several specimens of which were attached to different parts of the Sertularia. The body was of a vase or cup form, expanded at the top, and set round with numerous pointed tentacles abruptly thickened towards the base, and forming more than one row; they had very little motion, but were occasionally bent forward, and the whole were sometimes slowly retracted. The body was attached to the Sertularia by a tolerably short stem."

In another case he found a smaller one, "the tentacles capitate or knobbed at the end, and not so numerous as in the first." Mr. Alder states that in the first instance he took these creatures for Campanularian Zoophytes; but "found their organization more simple than in true polyps."

XUM

It is curious that, as Mr. Alder thought these creatures looked like Campanularian Zoophytes, or animals inhabiting bell-shaped cups, he should have omitted the mention of the cup in his description, and described the "*body* as of a vase or cup form." The tentacles of his objects differed in shape from mine, and were clearly not the same, nor should I have expected any strong resemblance, had I not noticed a copy of his drawings in the *Micrographic Dictionary*, pl. 40, figs. 13, 14, 15, which led me to further research. The drawings, especially 14 and 15, and those from which they were copied in the *Annals*, seem to show that the body of the creature is suspended in a bell-shaped cup standing on a stalk. At first these objects were named Alderia; but that appellation having been pre-occupied, they took their place among the Podophrya and the allied genus Ephelota in the last and fourth edition of Pritchard's *Infusoria*. In this position they were placed, as Mr. Pritchard informs us, by Dr. Strethill Wright. In my specimens certain peculiarities mentioned by Dr. Wright in the stem and tentacles of his Ephelota did not exist. The *Podophrya ovata* and *pyriformis* in Pritchard's *Infusoria*, and especially the former, seem, on the whole, to bear most resemblance to mine.

I have indicated the few points of resemblance between my creatures, which I believe to be *Acinetans*, and those described by Mr. Alder and Dr. Strethill Wright, and through the kindness of the last-named gentleman, to whom I am indebted for an obliging and valuable communication, I am able to state that his two genera, "Podophrya and Ephelota, differ from Acineta in having no cell or cups; but a chitinous solid stem sometimes enlarged at its summit. The internal part of the stem is either transversely or longitudinally striated with lines of growth." This settles the fact that my creatures were not Podophryans; but the distinction between cup and no cup is softened down in one specimen of Podophrya, of which Dr. Wright has favoured me with a sketch, and in which the top of the stem is hollowed out.

Dr. Strethill Wright finds in the neighbourhood of Edinburgh two Acinetans which are something like mine, but obviously not identical; and he informs me that the tentacles are often very obscurely capitate or knobbed at the ends: mine certainly had no knobs; but perhaps the distinction of knobs or no knobs is not always permanent.

GAUTIER ON THE PHYSICAL CONSTITUTION OF THE SUN.

The *Archives des Sciences*, 20th April, 1864, contains a paper by M. Emile Gautier, reviewing various observations, opinions, and discoveries of eminent astronomers, from the consideration of which he deduces the following conclusions. In giving these and other speculations we may be permitted to remind our readers that they supply a mass of hypothesis worth consideration, but certainly not to be accepted as ascertained fact.

1. "The sun is a liquid globe, incandescent, composed of elements like those which enter into the composition of the earth, and probably into that of the planets of the system. They exist in a state of liquidity, such as the earth passed through, according to the current opinions of geologists.* The high temperature which preserves the elements in a liquid form, necessarily dilates their volume, and explains the relatively small density of the fused globe."

2. "An atmosphere envelops the liquid mass, and holds in suspension vapours and emanations of all kinds, so that the inferior layers may be much heavier than those of the terrestrial atmosphere. The rotatory movement of the central globe need not be supposed to be transmitted to the most elevated regions of the solar atmosphere with the same angular velocity. We may therefore presume that the solar atmosphere exercises an action of rubbing or friction on the globe."

3. "The emanations or metallic vapours surrounding the sun, and impregnated with dust, smoke and lava, form around him a layer of variable thickness, and give rise during eclipses to the red borders and protuberances."

4. "The solar spots are partial modifications of the surface, due either to coolings, or to chemical actions that cause a momentary reunion in masses of salts or oxides issuing from the mass in fusion and floating on the surface. At the end of a certain time—which may exceed a terrestrial year—the chemical action of other elements, or an elevation of temperature, gives rise to new bodies. The dark nucleus of the spots corresponds to the thickest part of the solid crust; the penumbra to the pellicle, which in every formation of this kind is seen on the surface of a metal in fusion, and which is always produced about salt or scoriæ. Both are liable to be cracked, and to form figures through which the brilliant fused mass may be seen in the form of luminous bridges or spots."

* Geologists are not specially responsible for this opinion. Whether true or false, it is not evidenced by the superficial formations with which their labour lies.

XUM

5. "The faculæ are the result of the appearance on the sun's surface of substances that are more luminous, or endowed with a more considerable power of radiation. The conditions inherent in the roseate envelope of the solar globe, may also combine to give the surface the flocculent and uneven (*pommelée* and *moutonnée*) appearance which it presents.

6. "The acceleration noticed in the rotation of the spots situated near the sun's equator, is the result of the exterior action of atmospheric pressure on the liquid surface, combined with that of the inferior layers of the mass in fusion. As for the accidental irregularities, ascertained to exist in the movement of the spots, whether in latitude or longitude, they arise from the want of equilibrium, both physical and chemical, existing between the different components of this mass, which cause frequent whirlpools, both in the interior of the globe and in its atmospheric envelope."

THE DIDUNCULUS, OR LITTLE DODO.

BY W. B. TEGETMEIER.

THE extinction of several species of the lower animals through the agency of man is a fact that, unfortunately for the interests of science, admits of no dispute. Within the recent period of twenty years that most interesting water bird the Garefowl, or Great Auk, has been persecuted from off the face of the earth; and sixty-three or sixty-four stuffed and dissected specimens are all that remain to prove the existence of one of the largest and most powerful of our diving birds.

The British Museum sample was shot in the Orkneys in 1813, and the last known specimens were captured in 1844, and are preserved in the Museum at Copenhagen. Yet within the memory of old men now living, numbers of these birds existed on the Penguin Islands, near Newfoundland, but they were destroyed for the sake of their feathers. Now that this wanton destruction has been effected every effort is made to procure mutilated skeletons, or even a single bone of a bird in whose cause no hand was held out whilst it was alive; and the few specimens of the eggs that exist in our collections are valued at their weight in gold.

Those of the younger readers of the INTELLECTUAL OBSERVER who may be desirous of saying in their old age that they have seen a living specimen of an animal which will then no longer exist, should haste to the gardens of the Zoological Society to see there a bird that is the first, and will in all probability be

the last, specimen of the Didinæ, or family of the Dodos, that has ever been seen alive in Europe.*

Of the Great Dodo itself no perfect specimen remains. A foot in the British Museum, an imperfect skull at Oxford, some few engravings and paintings of the animal, are all that serve to show the previous existence of one of the largest, and what might have been most useful, of domesticated land birds. Its value as food, and its want of the power of flight, however, rendered it a desirable and easy prey to the earlier voyagers.

Until recently so little was known about the Dodo that its powerfully hooked beak led Professor Owen to place it among the birds of prey, and to surmise that its food consisted of reptiles and crustacea. Some other naturalists regarded it as allied to the gallinaceous group. Within the last few years, however, the more critical examinations of the scanty remains of the Dodo prove, without doubt, that it was a gigantic ground pigeon. This idea will not appear so startling to our preconceived notions if it is borne in mind that, in addition to the slender-billed seed and grain-feeding birds that constitute the group of pigeons and doves best known in Europe, there is a group of powerful hooked-beaked pigeons, feeding on the hard-shelled fruits of palms and firmly-husked tropical seeds, requiring a strong beak to crack the outer shell.

It is to this group that the extinct Dodo and the extant Didunculus belong. The former evidently employed its powerful bill in husking the fruits of the palms indigenous to the tropical islands it inhabited, in the same manner as the latter employs its beak in decorticating smaller fruits and hard-coated seeds.

All that is known of the history of the living Didunculus is soon told. About twenty years since, Lady Harvey bought a collection of Australian birds in Edinburgh. Amongst the skins was one about the size of that of a very large pigeon, of a dark chocolate and resplendent black colour, with the upper jaw or maxilla hooked like that of an owl; the lower jaw or mandible strong, broad, and furnished with three angular teeth at the apex or part that closed under the hook of the maxilla.

Sir W. Jardine described this unique specimen, and figured the head in the *Annals and Magazine of Natural History*, vol. xvi., 1845, and termed it Gnathodon Strigirostris. Being regarded as an Australian bird, it was figured under the same name in Gould's magnificent work on the *Birds of Australia*.

Subsequently the living animal was discovered, by Mr.

* The bird is now placed in the second compartment of the western aviary, which is situated to the right of the main entrance.

XUM

Titian Peale, of America, to be a native of the Samoan or Navigator's Islands; and it was named by him the Didunculus Strigirostris, the name by which the bird is now known. Nothing more was learned about this little Dodo until November in last year, when the following letter was received by Dr. Sclater, secretary of the Zoological Society, from Dr. George Bennett, of Sydney:—

"In the early part of June, 1863, a living Didunculus was brought to Sydney by Mr. J. Williams from Apia Upolu, one of the groups of the Navigator's Islands; and on the 15th of June, and the following days, I had several opportunities of examining the bird. At first it seemed rather shy and wild, but afterwards it became more tame, and I could examine it without its manifesting any fear. It is about the size of a Nicobar Pigeon (*Calœnas Nicobarica*), but rather bulkier and rounder in form. Its plumage was not in good condition owing to its having been recently confined in a cage on board ship, but it appeared healthy. This specimen, I should say, was a young bird with immature plumage, and the tooth of the lower mandible not yet developed. When I first examined it the bird showed its fear by occasionally uttering some rapid 'coos' and by fluttering in its cage, but it subsequently became quite tame. It was captured on the Island of Upolu after being wounded in the wing, and was sold by a native to Mr. Williams. It has now been in captivity about nine months, and is kept in a cage which is merely a box with rails in front, like a hencoop. Here it can run on the floor, or sit on a low perch, or conceal itself in the corners, as it is particularly fond of doing, where, with its dark-coloured plumage, it cannot readily be distinguished. When disturbed it would move gently and timidly across the cage, affording an excellent opportunity to the observer of examining it. It is a stupid-looking bird, and has no particular attraction, except the anomalous and extraordinary form of the beak, which cannot fail to excite the attention of the most ordinary spectator.

"The only sound it utters is the quick 'coo-coo-coo,' to which I have already alluded, the beak being always a little open when the notes were emitted. The whole of its plumage is of a chocolate-red colour, deeper in tint on the back, tail, and the primaries and secondaries of the wings; the throat, breast, and wing-coverts being barred with light brown. The upper part of the head was rather bare from the feathers having been rubbed off, but what remained were of a dark slate colour. The base of the beak is orange red, and the rest of the mandibles of a yellowish hue. The tarsi are not feathered, and the legs and feet are of a bright orange red, similar in colour to those of the Kagu. The irides are dark reddish-

brown, and the cere round the eyes is flesh colour. The bird is fed upon boiled rice, yams, and potatoes."

This letter was followed by a second, received by the following mail. In it Dr. Bennett says:—

"I have to add to my account of the bird sent last mail that this bird was captured within five miles of Apia, Island of Upolu; so that the bird is not yet quite extinct in that island, as has been supposed even by the resident missionaries. It is very fond of the mountain plantain, upon which it has often been found feeding in its wild state."

A third letter states:—

"Since my last letter another living specimen of the Didunculus has been brought to Sydney by the Rev. Mr. Rigg, who procured it from a native on the island of Savaii. This I have reason to believe is the identical bird that Mr. Trail, at the instigation of Mr. O'Hea, endeavoured to procure for me, as in reply to Mr. Trail's inquiries respecting the bird, the native informed him it had just been sold to a European on the other side of the island. On the day after the arrival of the vessel, I went on board and saw the bird, which is a much finer specimen than the one in the possession of Mr. Williams. It appears to be full grown, and in adult plumage—the head, neck, breast, and upper parts of the back being of a glossy greenish black; back, wings, tail, and under tail-coverts a deep chocolate-red colour; but I consider that the bird has only recently been changing its plumage, and that the present dark-green feathers will become more brilliant, and the chocolate-red colour of a still brighter hue. The legs and feet are of a bright red colour, and the claws yellowish-white. The mandibles are of an orange-red colour, shading off near the tips to a light yellow. The cere round the eyes is also of a bright orange-red colour; eyes, brownish-black. It is agreed by every one with whom I have conversed, who has resided at the Navigator's Islands, that the Didunculus is nearly extinct, from being eaten by the natives as well as by the cats, rats, and other vermin, and that most of the other ground-pigeons are following its fate from the same causes. The possessor of the last bird says he has never observed the bird to drink water since it has been in his possession. Its food at that time consisted of boiled yams, but it will eat bananas, apples, bread, and boiled potatoes. The lower mandible has the tooth well developed. This bird was very tame, and was eating some boiled yam very voraciously during the time I was inspecting it, bolting down very large pieces.

"This morning I examined both birds; they are evidently moulting, and the younger bird has grown very much since I last saw it, and is becoming now a much larger bird than the

XUM

last arrival; from this I am inclined to think they may prove male and female."

Of these two specimens one unfortunately died at Sydney; the other has arrived in safety at the gardens. This specimen is a female; it laid an egg on the voyage. This had been fortunately placed on a shelf, and was rescued from destruction by Mr. Bartlett; the egg is white in colour, and is about the size and form of that of a large variety of domestic pigeon.

The most striking peculiarity in the appearance of the Didunculus is the maxilla and great width of the lower-toothed mandible. This width of lower jaw is characteristic of whole groups of pigeons, and is intimately connected with the manner in which they nourish their young.

Both male and female, as is generally known, take part in the process of incubation. At the time when the young—two in number—are hatched, a peculiar secretion of curdy substance is formed in the crop of the parents. This is disgorged into the mouth of the young, and they are fed solely on this soft food for several days. The young are hatched in a very imperfect condition, and they receive this soft curdy food (which may be appropriately termed "pigeon's milk") by placing the beak nearly up to their eyes in that of the old one, and almost at right angles to it; so that the food disgorged by the parent is received into the expanded spoon-shaped lower mandible of the young. From this mode of feeding the young being universal in the pigeons, all, of necessity, have the expanded mandible, which hence becomes one of the best marked external characters of the group.

That these facts, simple as they are, are not universally known to naturalists, is evidenced by the fact that so good a naturalist as the late Mr. Yarrell, in his valuable treatise on British Birds, describes the old pigeons as feeding their offspring by placing their beaks in the mouths of the young ones.

The loss of the male Didunculus is deeply to be regretted; as, before the final extirpation of the last of the Didinæ, it would have been exceedingly desirable to ascertain the exact circumstances of their incubation and mode of rearing their young. What labour would naturalists of the present day not undergo, in order to see the unwieldy Dodo pumping up its soft food into the jaws of its young (!) Not having the Dodo, however, it behoves us to take the more trouble to ascertain the structure, habits, and food of its living congener, the Didunculus.

RECREATIONS IN NATURAL HISTORY.

Converting science into a recreation is by no means to be despised, as some "budge doctors of the stoic fur" might be disposed to assert; and the foundations of accurate knowledge and profound study have often been laid in the casual attention bestowed for the mere sake of amusement upon some curious or striking natural fact. It is indeed an excellent plan to present the recreational aspects of science first, and leave the inevitable hard work to be encountered after the student has obtained a glimpse of the fascinations that await him when he has passed from the wilderness of ignorance into the promised land of knowledge and truth. Dry treatises adapted to the school or the college might give the requisite start to a small number of determined workers; but the only way to raise up a large body of students of natural science, and to create a general interest in such questions throughout society is to make them a pleasurable exercise, in which large numbers can easily engage. This is the great function of the better class of popular works, in which the elements of experimental or descriptive science are exhibited in an entertaining guise. Some men fancy they must be learned because they are tiresome, and sneer at any knowledge that is not reduced to its most repulsive technical form. They would degrade natural history to an insufferable catalogue of long-tailed names, and try to persuade themselves and the public that the observation of character and habits is unimportant, and that the one thing needful is to acquire the art of arranging objects upon a system, so as to put them into the right pigeon-hole as soon as they are seen. Systems of nomenclature and classification are no doubt indispensable, but they do not constitute science. They are only part of its mechanism, and of no intellectual worth, unless they are associated with clear and positive ideas of structure, development, and modes of life.

Natural history may be approached in a popular and amusing manner in two ways. According to the first, the objects may be viewed in relation to habit and structure; and according to the second, in relation to the use or mischief they do to man. Books of great interest have been written upon both plans, and form no small proportion of the healthy literature which our age provides for family reading. To be successful they demand on the part of their writers considerable acquirements, coupled with the happy art of presenting the salient points of their subject in an intelligible and pleasing light. Mr. Wood has recently added to his labours in the first of these departments a very pleasantly written work, now appear-

XUM

ing in monthly parts, entitled *Homes without Hands*, in which the constructive faculties of all kinds of animals are agreeably set forth; and Dr. Phipson has selected an excellent set of subjects under the title of *The Utilization of Minute Life*.* If we were disposed to be hypercritical we might say that some of the living creatures whose utility to man forms the theme of Dr. Phipson's essay, are not exactly *minute*, as that term is scarcely applicable to the lobster or the crab; but the general appropriateness of the title will be apparent when we proceed to enumerate the contents. First, we find the Silk-Producing Insects, then the Colour-Producing Insects, then Insects producing Wax, Resin, Honey, and Manna; after which the Insects Employed in Medicine, or as Food, and other Insects useful to Man, are treated in a manner that conveys a great deal of zoological and technological information in a very pleasant way. After the insects Dr. Phipson deals with the Crustacea in one chapter, and with the Mollusca in another; and the work concludes with Worms, Polyps, Infusoria, and Sponges. From this enumeration of subjects it will be apparent that Dr. Phipson has addressed himself to the widest possible range of readers, and by a happy union of chemical, zoological, and technological science, he has provided matter to suit all tastes.

At the present moment two of Dr. Phipson's subjects are especial matters of interest, and to them we shall confine our remarks; first adverting to the efforts for increasing the production of silk, and secondly to the plans in operation for the artificial propagation of mollusca serviceable as food. Attention has been strongly directed to the introduction of new species of silk-producing insects, and to the prevention of the diseases which have proved so ruinous in many silk arms. Amongst the diseases we find "muscardine," caused by a parasitic fungus, for which cleanliness and the removal of sick larva seems the most effective remedy; "atrophy" or "rachitism," "gangrene," "jaundice," "apoplexy," "diarrhœa," "dropsy," for which different methods of treatment are prescribed. "In the department of Vaucluse, where on a small area of land more than two millions of mulberry trees are grown, gangrene resulting from these and other maladies is arrested in its course by sprinkling quicklime over the larvæ by means of a very fine sieve, and then covering them with leaves soaked in wine." The list of complaints sounds shockingly human, and affords a curious, though scarcely pleasing picture, of unity of plan in

* *The Utilization of Minute Life*; being Practical Studies on Insects, Crustacea, Mollusca, Worms, Polyps, Infusoria, and Sponges. By Dr. T. L. Phipson, F.C.S. London. *Groombridge and Sons.*

nature's works. We do not know whether the old-fashioned race of silkworm doctors endeavoured to cure their wriggling patients by cathartics and depletion; but it is interesting to find that in the case just mentioned the system which used to be named antiphlogistic is dispensed with, and alcoholic stimulants exhibited, in conformity with the practice of our best hospital doctors and the interesting theory of Professor Lionel Beale, who would tell us that when the unfortunate silkworm was being reduced to a black fetid liquid through the agency of disease, a little alcohol would moderate the excessive action of the growing material, and restore the balance which health requires.

Dr. Phipson mentions the great success attained by M. André Jean, the director of a large establishment at Neuilly, who has succeeded in introducing a splendid and very large race of silkworms, by breeding exclusively from well-selected specimens.

In addition to the ordinary silkworm the French are occupied in naturalizing other species, especially a fine one from the Himalayas, which lives upon the oak. The Tussah silk is coarser than the silk commonly known in this country, and the worms producing it may probably be reared in European countries to an extent sufficient to exercise an important influence on the ordinary clothing of the people. Dr. Phipson states that "garments of Tussah silk will wear, when in constant use, for ten or twelve years;" and M. Guérin de Menneville has obtained from cocoons of his own rearing "silk so strong, that a single fibre will support without breaking a weight of 198 grains."

A recent number of the INTELLECTUAL OBSERVER contained an account of the employment of spiders to make carpets, and other European insects have been used for their spinning powers. Dr. Phipson has the following remarks upon this subject, and we are enabled to make the quotation more interesting by presenting our readers with one of the numerous excellent engravings with which his book is illustrated:—

"It is a doubtful question whether the breeding of any of the European moths will ever become a source of advantage. Experiments have already been made on certain varieties of clothes moths (*Tinea*). M. Habenstreet, of Munich, experimented some years ago upon a species called *Tinea punctata*, or *Tinea padilla* (Fig. 2), closely allied to *T. Evonomella*. The larvæ of the former were made to spin upon a paper model, suspended from the ceiling of the room. To this model any form or dimensions could be given at will, the motions of the larvæ being regu-

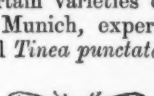


FIG. 2. Tinea padilla (Silk-spinning gnat).

lated by means of oil applied to those parts of it which were not intended to be covered. The investigations showed that on an average two of these larvæ can produce a square inch of silk, and when employed in great numbers their produce is astonishing. M. Habenstreet succeeded thus in manufacturing an air-balloon about four feet in height, one or two shawls, and a complete dress with sleeves, without any seams. The tissue thus curiously produced resembled the lightest gauze, which it surpassed in fineness. We are told that the Queen of Bavaria once wore a robe of this description over her court dress."

Leaving the insect department of Dr. Phipson's work we pass to the chapters on Mollusca, and hope that the repetition in his pages of the accounts of what the French are doing will stimulate exertions to add to the quantity of food produced by our shores. Artificial fish breeding should be supplemented by similar methods of increasing edible mollusks and crustaceans. Nothing can be simpler than M. Coste's plan on the coasts of France. In Dr. Phipson's words, "he gets fresh oysters for propagation from the open sea; he turns to advantage those which are rejected by the trade; and lastly, he collects the myriads of embryo oysters which at each spawning season issue from the valves of the oyster, and which are now lost to commerce for want of some contrivance to prevent their escape and inevitable destruction."

Out of two millions of young produced by a single oyster, only ten or twelve attach themselves to the parent shell, and to save the mass of spawn M. Coste employs a very simple plan, of which we annex a sketch, borrowed from Dr. Phipson's work (Fig. 20). So easy is the artificial cultivation of the oyster

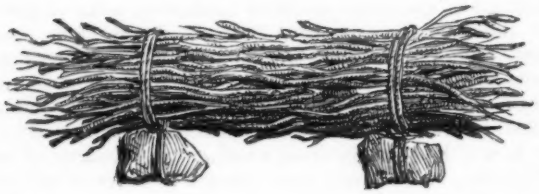


Fig. 20.—Bundle of faggots for propagating oysters, according to M. Coste's system.

that "about five-and-twenty thousand acres of coast may be brought into full bearing in three years, at an annual expense not exceeding £400." The young oysters attach themselves to the fascines, and at a suitable age are transported to a zone of the right depth.

Zoologically speaking we ought to have noticed the lobster

and crayfish before the oysters; but in the classification of domestic economy, the latter are the most important. We may, however, mention that both the lobster and the crayfish may be bred artificially and rendered a cheap article of food. The lobster produces from 15,000 to 20,000 eggs, and the crayfish upwards of 100,000. There is thus plenty of material to work upon, and the principal apparatus is a breeding trough, as shown in Fig. 10, to which we are indebted to Dr. Phipson's work.

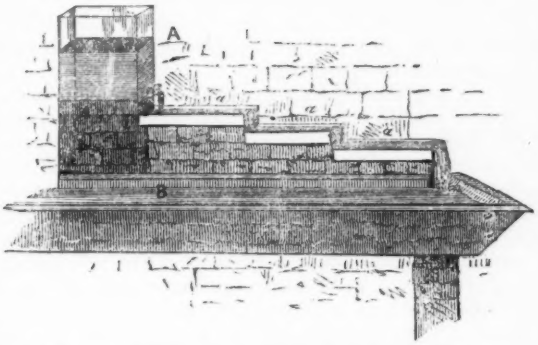


FIG. 10.—BREEDING TROUGHS FOR HATCHING EGGS OF CRUSTACEA, etc. (From a sketch taken at the College de France, Paris.)

A. Cistern. *a. a. a.* Glass troughs, containing gravel: the water flows constantly from one to the other in a gentle stream. B. Large trough for salmon, etc.

We are so convinced that to be generally useful, scientific books must be interesting, that we have given particular prominence to that element in Dr. Phipson's labours, and we are glad to be able to recommend it strongly on that account. We do not, however, wish to convey the impression that, because it is popular, it is not scientific. This is certainly not the case; but the work belongs to the department of Recreational Science, because it relates exclusively to matters that, although not generally known, are interesting and easily understood.

XUM

THE FUNCTIONS OF ART.

We do not intend to criticise any individual pictures in the Royal Academy Exhibition or elsewhere. The number of pieces that will receive popular praise or blame will depend chiefly upon the expectations the visitors to the various galleries form concerning the functions of art. If they ask the painter only for clever finger work, they may soon fill up a large laudatory list; but if they demand clever brain work also, they will strike the pen of condemnation through the majority of the names of pieces which they were compelled to praise upon mere technical grounds.

In reading the works of our best modern historians, the graphic power of reproducing and idealizing characters and events gives a charm and value to their pages that we seldom find when we turn from paper to canvas, and expect the pencil to rival or transcend what the pen has accomplished to make us realize the past. If the historian puts together his sentences with technical skill, if his periods are flowing, his grammar unexceptionable, and his meaning plain, we esteem him little, unless he rouses our emotions, excites our sympathies, and gives us some insight into that eternal linking of cause and effect, without which life would be a disjointed and purposeless drama, and the incidents of human story mere rags and tatters of a many-chequered scene. No cleverness of composition makes us merciful to the writer who fails in those higher purposes which composition ought to serve; and why should the man who speaks to us through the mechanism of oils, pigments, and canvas, obtain laudation upon easier terms? If he undertakes to bring before our eyes scenes connected with the assertion of political liberty, or with the insurrection of mind against the conventional forms of dead systems, we ought, before praising his picture, to ask whether, after studying it, we know more of the subject than we did before his labours were exposed to our view, and whether the meaning of the event is more distinctly felt and seen. His anatomy may be unexceptionable, bones and muscles may be in their places; his figures may be well arranged, and their drapery of shape and hue that is pleasing to the gaze; but still, he has failed as an artist, unless the soul and sentiment of the subject glows through every lineament, and gives a moral and intellectual reality to all his work. What is the use of telling an heroic story so as to excite nobody to heroic thoughts or deeds?

Passing from the historic to the domestic, what do the silks and satins, the muslins and the crinolines matter, and what are they worth on canvas more than so much linen-

drapery stock, unless the picture in which they glisten suggests a thought worth having, or an emotion that makes life truer and more beautiful than it was before. Interiors of cottages, village schools, and scenes of amphibious existence on the sea-shore, ought to be something more than works of imitation, tinged with the personal egotism of their manufacturers, before they are entitled to demand our praise. Is there nothing in the peasant life of England but gnarled or chubby faces, fat bacon and hunks of bread? Is there nothing in the interior of our cottage homes—miserable dens though too many of them be—but carrots and crockery, a deal table and a mug of beer? Those who paint peasant life as made up of these beggarly elements, had better leave it alone. You may see the grain of the wood floor, count the knots in the table, feel disposed to pick up the potato peelings, and be a profound believer in the patches on the clothes; but if the painter has seen nothing to idealize, if he excites no sensation of human worth, if his men, women, and children have nothing in them but simple animal characteristics, tinged with want, or degradation, no merit in his brown pitchers or clouted shoes should induce any one to fancy that he has produced a work of art.

Cottage scenes are common enough in our exhibitions; but how few painters perceive the pathetic or the nobler sides of humble life. And yet we know that where the common-place mind can see only its own miserable reflection, there may be enough heroic devotion for a Thermopylæ—enough strength and tenderness for a whole calendar of saints.

We want in art the mind of a poet-thinker, turning everything it touches to living gold; and after an exhibition has been gone through, and the physical fatigue of the process is over, he alone should be dignified by the name of an *artist* who has taught us how to see, or how to feel, or how to think, more truthfully and more beautifully than before. Take aspiration away from art, and it becomes so much dead lumber. If it leaves its votaries with just so much indifference to bad things, and no more love of good things than they previously possessed, it has failed of its purpose; it is like an instrument from which no music can be evoked,—a bell that will not ring, a book that proves to be nothing but leather and wood.

Very often indeed the painter comes forward as the expounder of our great writers, and many works receive high praise upon the merely technical ground that the art-spelling is done properly, when no art-words are put together by which the verse of the poet becomes a stronger and more exquisite reality in our minds. If reading the poem gives us a better picture, the painter has been of no use. We are entitled to ask him to do more for us, than our own imagination could easily

XUM

body forth. Failing in this, however clever he may have been with his fingers, we do not thank him for his brains.

The artist goes forth at all seasons of the year into the country, and in due course elaborates his landscapes. Here again, after demanding technical correctness, we are entitled to ask for something more. If his canvas looks like the place, and that is all, his human intellect and heart have done little more for us than the photographer's chemicals and lens. If we go to the spot he depicts with no finer associations than we should have had without him; if he has given us small help in seeing, and none in the loftier process of linking together the beautiful and the true; what ought we to care for his work, although its precision might serve to guide the carrier to the right roadside inn, or suggest to maternal solicitude a convenient situation for sea-bathing when the children's holidays arrive.

There is a class of landscape very common in our galleries, and yielding ample profits to its producers. We mean that in which some harsh and discordant effect of blazing light and colour is repeated with certain changes over and over again, and year after year. In another case a man carries his own eternal tameness to every scene—his waterfalls are composed of the same soapsuds, his trees have the same mild stems, and the same pale green leaves; his rocks are smooth enough for the drawing-room table when the cover is off, and his skies simper with one unvaried smile. He is no helper to see or think, not an *artist*, however deftly his brush may glide. Certain other men have discovered an "effect" that will sell, and they produce their effect year after year, just as the crockery maker gives us the everlasting willow plate. In many instances, a certain crotchety egotism and mannerism always comes uppermost. It is evident that artists of this stamp do not look nature honestly in the face. They project one side of themselves upon all they behold. They are not interpreters of nature, nor can be until they have exorcised the demon of self.

Doubtless we have good artists, as well as good brushmen; but tried by their appeal to men's higher faculties, not one picture in a hundred that fetches a high price, and secures the laudation of the common herd of critics, really deserves the name of a work of art. We believe our artists will give more when the public demands more. It is therefore we would stimulate the public demand.

NEIGHBOURHOOD OF THE LUNAR SPOT, *MARE CRISIUM*. JUPITER'S SATELLITES. OCCULTATIONS.

BY THE REV. T. W. WEBB, M.A., F.R.A.S.

Our somewhat lengthened examination of the interior of the *Mare Crisium* did not admit of our extending our survey beyond its immediate boundaries. Its vicinity contains, however, some interesting features. The surrounding elevated land is broken up in many places by eruptive force, and some of the craters deserve a passing notice. *Condorcet* (see the diagram in our April number) is a considerable crater, 45 miles in diameter, with a very regular interior, but an exterior quite the reverse, as is frequently the case where such formations occur in mountainous regions. It is about 8900 feet in depth. *Azout* is a similar but smaller crater, 16 miles in diameter; its interior has only 2° of grey light. Four ridges of some height, and nearly equal in length, run from its wall to the "sea," including between them three sloping bowl-shaped valleys. Watercourses, if they were possible upon the moon, might be looked for in such localities, which are not of frequent occurrence. This is the remark of Beer and Mädler, to whom the reader will understand that he is indebted, throughout these papers, for all statements not expressly referred to other authorities. I regret that in this, as in numberless other instances, I can add no corresponding observation of my own; and that with regard to the greater part of the lunar surface I am unqualified to act as guide, excepting upon the information of others. *Firmicus*, more than 38 miles broad, and nearly 5000 feet deep, is connected with *Azout* by a mountain ridge. Like the preceding craters it is of a uniform dark "steel grey," which, under a high illumination, though of the same intensity of light with the *Mare Crisium*, is different in colour, from the intermixture in the latter case of green. *Apollonius*, 30 miles in diameter, is nearly S. of *Firmicus*, and is the furthest in that direction of this crater group. The summit of its S.E. wall is 5400 feet above the interior.

To the W. of this object we come to a more level country, remarkable under high lights for a set of broad, crooked, and branching streaks of dark grey, somewhat resembling, according to B. and M.'s remark, the Saima lakes in Finland. They seem under such circumstances to lie in a perfect plain. Near the terminator, however, they are perceived to be valleys divided by banks of moderate height, and associated with

XUM

craters. The aspect of the district is then so changed, that its correct identification as to details requires actual measurement. These great discrepancies, they observe, might easily lead to the idea of casual atmospheric obscurations or other changes; but continuous and persevering observation shows that they are all periodical, and so entirely dependent upon the angle of incident light, that an ephemeris of these phenomena might be constructed to serve for every lunation. Vegetation has been suggested, according to B. and M., by several astronomers, as the cause of these appearances; if so, it would require to be of a nature to run its course in a single lunation. In favour of this idea it might be alleged that many valleys of a precisely similar character are to be met with, especially nearer the Poles, that show no such grey tint, but preserve their bright aspect under high illumination.* All this, however, is little to be depended upon; and it must be admitted that vegetation, in the absence of air and water, is to us incomprehensible. It had already occurred to Schröter that the moon, from the very slight inclination of its equator to its orbit, could possess scarcely any change of seasons; and that therefore the functions dependent with us upon summer and winter, might there be discharged by its lengthened day and night; so that vegetation might be concerned in the change of colour for which some spots are remarkable as contrasted with others, in proportion to the increased angle of the sun's rays. Gruithuisen, as might have been expected from him, pushed the matter much further. He distinguished the grey spots into three classes, each, as he fancied, characterised by a "flora" of its own. 1.—Small levels of a very dark hue, which undergo no change, and may possibly be covered with forests of conifers! 2.—Numberless dark spots which acquire a deeper tone under the advancing light, among which he classes the *Paludes Amaræ* of Hevel, the very region we are now discussing. 3.—The grey plains, which gradually grow darker after sunrise, probably from the dispersion of a low mist. And besides these he noticed traces of another kind of lunar flora, requiring great attention to be perceived, reaching as far as 25° of N. latitude, and gradually creeping up the valleys among the mountains as the sun attains its greatest height. From all this he concludes that there is a lunar vegetation comprised between 65° N. and 55° S. latitude, most luxuriant near the equator, and preserving an analogy between increasing relative height and latitude similar to that which obtains on the earth. Our readers could not be much won-

* It escaped B. and M. that near the Poles the sun's altitude would never be sufficient to admit of a fair comparison.

dered at if they were to consider this "all moonshine," nor would a closer acquaintance with the author increase their confidence in his judgment. But he had a very fine eye, and there may be hints here not to be despised. As to the general question of vegetation, no doubt a flora like our own could not exist under such very adverse conditions. But this would furnish no argument against the possibility of one adapted to its peculiar situation, and we must not omit to mention that one of our first authorities on this point, De la Rue, is inclined to favour such an idea from the circumstance that in the course of his photographic investigations he has found that parts of the moon, equal in apparent brightness, are by no means equal in actinic energy. This indicates the presence, in certain situations, of rays not otherwise manifested, which are incapable of producing a photographic effect—such a result as might naturally be expected if those portions of the surface were clothed with vegetation.

I have been repeatedly struck with the very singular aspect of this region under a high illumination, in its uncommon contour and sharply-defined intermixture of light and darkness; and I venture to think that a very careful study of it might probably be in some way ultimately rewarded. We have not, as far as I am aware, a single representation made on an adequate scale, and with sufficient accuracy, of the appearance of this district in the full moon, and the attempted delineation of B. and M. is scarcely so successful as the rough but characteristic draught given by old Hevelius, of what he calls his "Paludes Amaræ." This is in fact not surprising. The object of Beer and Mädler, as of Lohrmann before them, having been the delineation of the elevations and depressions of the surface, any adequate representation of those varied tones of grey and white, to which the term "local colour" may be conveniently though not very correctly applied, and which are so strangely unconformable with the actual relief, would have been a simple impossibility. Hitherto the attention of selenographers has been, naturally enough, much more directed to the very intelligible relief than to the intricate and perplexing shadowing of the surface; and hence we do not as yet possess either special topographical delineations, or a general map of the full moon, at all corresponding with the present requirements of science.* A general chart would demand a great expenditure of time and labour, especially if the gradations of light are accurately represented, without which it would be of little service; but careful drawings of separate spots might be very advantageously un-

* Russell's, fifteen inches in diameter, published about 1797, is the best that I have seen, but it is rather a spirited sketch than a faithful likeness.

XUM

dertaken by amateurs, and would be easily executed with a little skill in outline and shading: their comparison with views of the same objects in the relief of light and shade would be instructive, and they might in process of time acquire considerable importance as records of the present state of a surface, whose markings may perhaps be found not exempt from change. But to return to the *Paludes Amaræ*, or *Neper* a* and its neighbourhood, as this region is styled by B. and M.: grey tracts of a similar character, but perfectly unconnected with these, and less extensive, are to be found at no great distance to the W. of the craters *Hansen* and *Alhazen* of B. and M. (see the diagram of the *Mare Crisium*); another of these streaks lies between the *Alhazen* of Schröter and *Eimmart;* and B. and M. describe several less easily seen in the extreme foreshortening of the limb.

The region between the S. end of the *Mare Crisium* and the equatorial limb of the moon, comprising the craters *Neper* and *Schubert*, has been very unsatisfactorily laid down by B. and M. The result of Mr. Birt's revision of their work will in due time, we trust, be made public: in the mean while, as the requisite correction involves a still larger district lying on the other side of the equator, we shall postpone our notice of it till it comes before us in the Fourth Quadrant.

There is nothing of especial interest to the W. of the *Mare Crisium*. To the N. and NW. we meet with an elevated region, as extensive as Germany, so entirely filled with craters and ring-plains that the intervening mountain ridges are reduced to a position of very inferior importance, and appear to serve principally as means of communication, so to speak, between the more conspicuous features. Several of these latter we shall describe in detail.

Cleomedes (No. 1 in the Index Map) is a fair specimen of the formation which has been at different times styled a Walled, Bulwark, or Ring Plain. This peculiar configuration of the surface differs from the crater chiefly in the level character of its interior, which is frequently little, if at all, depressed beneath the surrounding neighbourhood. It appears to be the type towards which the larger and older craters approximate; but it is difficult to obtain a clear or satisfactory idea of the mode of its original construction, or the stages through which it may have passed. We shall find, however, hereafter still more characteristic and better situated specimens than the one now before us. *Cleomedes* is about seventy-eight miles in diameter, and of a rounded quadrangular form; less dark than the *Mare Crisium*, and not everywhere of a uniform tint. Schröter has noticed that it is deepest beneath the E. wall, a peculiarity

* This letter in the map has more resemblance to a "d."

exhibiting itself, he says, in several other similar great plains, especially *Grimaldi*. The wall is very broad, and falls on each side in terraces—a mode of formation frequently recurring in lunar rings, and worthy of careful attention: it reaches a height on the W. side of about 8700 feet above the interior, rising on the E. side nearly 1000 feet higher, and, dividing in its course, encloses on the NE. a steep depression named *Tralles*, lying no less than 13,700 feet beneath its E. boundary. Several of the neighbouring smaller craters are also, as Schröter has remarked in this and numerous other instances, deeper than the principal cavity with which they appear to be connected. It is a fact especially worthy of attention, that, as this observer has pointed out, when one crater has encroached upon the boundary of another, so as to be obviously of subsequent date, the more recent is almost universally the smaller, as well as the deeper, either absolutely, or at least in proportion to its diameter.

The area of *Cleomedes* contains several small objects. Schröter at first saw three, a low hill in the centre between two loftier objects, of which that to the S. might possibly be a crater, all reflecting an ordinary light of about 4° of intensity. Subsequently, under an angle almost precisely similar, he found the N. spot changed from a longish ridge to a crater of considerable size, and a brilliancy of not less than 7° or 8°, approaching that of *Aristarchus*, the brightest spot on the moon. In another lunation the ordinary-looking hill and its shadow reappeared. On another occasion he saw in this place both the ridge and two craters, the smaller of which had 6° of light, close to it; and subsequently he found the larger crater grey instead of white, and a black shadow in both of them, especially the smaller one, though 6′ 40″ to 7′ removed from the terminator, and though a neighbouring very deep crater (*Bernouilli*) had lost nearly all its shade—thus indicating extraordinary depth and steepness. He had been early persuaded, from many such observations, that "the existence of real accidental workings of nature, not dependent upon the different reflection of light, lies so evidently before our eyes, that if any one would desire a yet stronger conviction, he would do better to give up altogether the closer investigation of the lunar surface, since he (Schröter) did not believe that, with due regard to our shortsightedness, more obvious proofs were possible;" and he thinks it hence certainly demonstrated that these changes are partly atmospheric, depending upon the condensations and clearings up of different seasons, and partly indicative of other unknown agencies working according to the peculiar nature of the surface. In this respect he calls attention to the variations in the colour of the area of *Cleomedes*,

XUM

at some times much brighter and more uniform than at others; this, he says, may partly arise from a different angle of reflection, but is probably in part also atmospheric, resembling the periodical changes of weather in some portions of our globe. For, he argues, if reflection alone were concerned, why should the change extend uniformly over the whole breadth of the surface, instead of advancing across it by degrees? and why should not many other similar surfaces be similarly affected? while, on the contrary, as a general rule, the greater spots preserve their colour invariable, whether bright or grey; of which he alleges *Copernicus* and *Plato* as instances, and the large spots in the immediate vicinity of *Cleomedes* itself. He has also called attention to similar variations in the immediate neighbourhood of *Cleomedes*, especially between it and the *Mare Crisium*, where black shadows and grey patches among the mountains exhibited to him a strange inconstancy of aspect, even under similar angles of incidence and reflection of light. As to all this, Beer and Mädler would be at issue with their predecessor, and would resolve the whole affair into the effects of varied illumination. It is very probable that there may have been more in this than Schröter has allowed for; and as the question affects the labours of future selenographers, and may prove perplexing to the uninitiated student, it may be well to give some attention to it in this place.

That apparent change of position in the lunar spots which is termed Libration, arises, as is well known, from two independent causes, and the whole effect is a combination of the results of each. Libration in longitude—which causes sometimes more of the E., sometimes more of the W., limb to come into sight, and throws the mean apparent centre of the moon at one time into the E., at another into the W. hemisphere—arises from the unequable velocity of the moon in its elliptic orbit, combined with its equable rotation on its axis, whence any given point on its surface will sometimes appear in advance of, sometimes behind, its mean position. This will, of course, alter the perspective projection of all objects in an E. and W. direction, affecting the equator most strongly, the poles not at all; while, as regards the direction of the incident solar light, and the corresponding amount of shadow, the result will be the same as if the globe of the moon were swung slightly round its axis, backwards or forwards, as the case may be, alternately on each side of its normal or mean position. The *real* length of the shadow will thus be a little varied, by turning the object somewhat to or from the sun, and its *projected* (or apparent) length, by turning it somewhat to or from the eye; the former effect being greatest in the centre, and least near the limb, the latter greater at a distance of 45° from the centre than in either of those two positions. The extreme

amount of this libration in longitude may be 7° 55′ each way. The other kind of libration, that in latitude, is of a less simple nature, and its effect is not so readily allowed for. It arises from the fact, that the plane of the moon's equator is coincident neither with that of the earth's orbit nor its own. Were all these identical, the moon's equator would always pass as an imaginary straight line across the centre of the disc, and the poles would stand exactly in the limb. But, as the moon's orbit is inclined to the ecliptic at a mean 5° 8′ 49″, the lunar globe is carried, during each revolution, alternately above and below the level of the eye; and hence the equator is sensibly straight only when the moon is in its node or passage across the ecliptic. At all other times it is projected, either upwards or downwards, into a narrow semi-ellipse of continually-varying dimensions corresponding with the moon's latitude, and each polar region in turn comes more into sight, or passes away into the invisible hemisphere. Such would have been the case from the inclination of the orbit, even had the plane of the moon's equator been coincident with, or parallel to, that of the ecliptic; but, in addition to this, it is inclined to it at an angle of 1° 28′ 47″; so that the whole change in projection, in a N. and S. direction, may amount at a maximum 6° 47′ on either side of the mean position. This has, of course, the same effect as the libration in longitude, in proportion to its amount, on the perspective foreshortening of the surface, though not, like that, in an E. and W., but in a N. and S. direction. On the contrary, it has no influence on the *actual* length of the shadows; though, from its allowing us to see sometimes more, sometimes less, of the foreshortened interior of a crater or base of a mountain, there may be a little change in their *visible* extent. It has, however, an effect of some importance on the *direction* in which the shadows fall. We have been referring only to the angle under which we view the surface—in other words, the angle of reflected light; but the angle of incident light has also to be considered, since it also varies, though to a less degree. The deviation of the moon on either side of the ecliptic, is, in this case, less important, the 380-fold distance of the sun rendering its angular amount there so much less than it subtends at the earth; but the inclination of the lunar equator to the ecliptic, as seen from the sun, produces the full effect of its angular value; and the moon's axis being tilted at one time towards, at another from the sun, the direction of the incident light will be varied in the same way, though by no means in so great a degree, as in the different seasons upon the earth; the sun will not rise and set at precisely the same points of the lunar horizon, or attain exactly the same meridian altitude; and hence, the appearance of objects may be much varied, especially of such as lie nearly in

XUM

an E. and W. direction. For instance, the face of a cliff may, from this cause, in one lunation be visible in feeble illumination; in another, at the same age of the moon, it may be entirely darkened itself, and even cast a perceptible line of shade. Gruithuisen pointed out the effect thus produced on the dimensions of the shadow of the lunar *Apennines*, but it seems not to have been duly allowed for by Schröter.

While the direction both of incident and reflected light is thus continually changing from the combined effect of the two librations, it is easy to see how optical illusions may be of continual occurrence, and how objects whose diversified planes and angles render their aspect peculiarly dependent upon the mode of illumination, may often exhibit themselves in a strangely altered guise; and the fact that even the *maxima* and *minima* of libration are subject to some amount of change, although slight, from the peculiarly variable character of the lunar orbit, introduces still greater difficulty into the attempt to eliminate, from observed appearances, this fruitful source of uncertainty and deception.

The student will, it is hoped, regard with indulgence this disquisition, which has extended itself far beyond the original intention, and which goes in part over ground traversed upon a former occasion. To some readers it may appear very uninteresting. But, as far as I have observed, the differing character and combined result of the two librations have not been fully and distinctly elucidated in the ordinary treatises on elementary astronomy, though it is of especial importance that the subject should be clearly understood by the selenographical student: in no other way can he form a just notion, from his own observations, of the probability of actual change in progress on the lunar surface, or of its being subject to atmospheric obscuration; and in no other way could we expect to bring to any satisfactory conclusion a comparison of the labours of our predecessors. In the present, as in many another instance, B. and M. challenge the supposed variations of Schröter. On the grounds just assigned, implied rather than distinctly explained by them, their position may be defended, that the alleged changes may be accounted for without the supposition of physical alteration. On the other hand, in behalf of Schröter's idea, his own argument may be adduced, that such merely optical effects must be confined within narrow limits, or the whole surface would appear to be in a state of fluctuation and uncertainty, and changes would supervene in the course of a few hours' observation; experience showing, on the contrary, a great and general uniformity, which renders the occasional exceptions the more remarkable: to which may be added that all such variations must be periodical, and would

ultimately compensate themselves under the eye of a patient observer:—the epoch of mean libration returning almost exactly at the end of every three years. So that at present the decision of this curious question may perhaps be considered as in abeyance: if we are forced to conclude that Schröter was often mistaken from not sufficiently adverting to the effects of libration, or from his imperfect mode of measuring it, we may ourselves occasionally err on the other side, and only impede fair and full investigation, by ascribing everything which we do not know how to account for to this cause alone.

To return in conclusion to *Cleomedes*, the original source of all this discussion. The objects in the interior specified by B. and M. are, a central hill, 6° bright in the full moon, but not very distinguishable under oblique illumination: it is not evident whether this is the same with the hill described by Schröter, or whether what he saw was a part of the ring of a small crater (B in the map of B. and M.), a little S. of it: three deep craters equally luminous in the darker S. part, of which the map shows but two, that furthest S. lying, where Schröter once perceived it, at the foot of the wall:—and in the N. part three somewhat larger, that in the W. 8° bright and very conspicuous, but, as even these advocates of unchangeableness are obliged to admit, not always equally defined, in the full moon.

Gruithuisen tells us that, 1825, April 6, he saw distinctly in the W. part of the interior of *Cleomedes* elevations resembling long straight hills, including several rhombus-shaped spaces between them. These rapidly became invisible, and he thought the appearance indicative of something artificial, perhaps connected with cultivation. His figure, as engraved by Bode, represents between the W. wall and the central hill, which is double and casts a long shadow across half the plain to the WSW. (thus showing the libration at the time), an object of considerable size, like a lozenge in heraldry; in fact, a foreshortened square lying obliquely, subdivided into four similar spaces by a cross-bar each way. But Gruithuisen himself condemns it as an unsuccessful representation.

In an old sketch of my own, 1849, April 26, the central hill is also represented as distinctly double; and there are two craters to the N. as in Schröter, the larger one having, as he has described it, a small elevation in the midst of its grey interior. I have not yet examined *Cleomedes* with my present instrument.

On a mountain plateau, a little to the left of this great ring, B. and M. describe a crater between four and five miles across, on whose wall another of one-third its diameter has encroached. This latter is worthy of notice, as being apparently deeper than it is broad.

XUM

TRANSITS OF JUPITER'S SATELLITES.

June 6th. Shadow of II. departs, 10h. 13m. 7th. I. enters, 12h. 20m.; its shadow, 12h. 56m. 9th. Shadow of II. goes off, 9h. 37m. 13th. Shadow of II. enters, 10h. 27m.; II. goes off, 11h. 20m. 16th. I. departs, 10h. 45m.; its shadow, 11h. 31m. Shadow of III., 11h. 33m. (an interesting conjuncture; the two shadows will appear on the disc together, that of III. being distinguishable by its larger size and slower motion, and they will pass off nearly at the same time). 20th. II. enters, 11h. 20m. 23rd. III. enters, 9h. 49m.; I. follows, 10h. 21m.; shadow of I., 11h. 14m.; III. goes off, 11h. 52m.; its shadow not entering till 13h. 22m.

OCCULTATIONS.

June 11th. p^2 Leonis, 6 mag., 10h. 38m. to 11h. 37m. 17th. ω^1 Scorpii, 4½ mag., 12h. 27m. to 13h. 34m.

ON THE HERRING.

BY W. NEWTON MACCARTNEY, COR. SEC. G. N. S.

THE history of the *Clupea harengus* is but imperfectly known, our information comprising only a few more easily observed facts, while those habits which would assist us in the preservation and cultivation of the herring-fishery have as yet escaped our notice. What has been discovered is only the foundation for future efforts, which, if conducted systematically, cannot fail to produce valuable results. While our information concerning some of the lower forms of life is so complete, it is to be regretted that our knowledge of the herring is so meagre, for we lay ourselves open to the *cui bono* of the utilitarian, who, ever ready to pounce upon the naturalist, demands why we spend time unravelling the generation of the medusæ, the animality of the zoophytes, and other questions, to the neglect of those which, like the habits of the herring, have a greater interest, and are of more economic value. As yet, it must be confessed, deep mystery hangs over such questions as the age, season of spawning, and many other habits of the herring, which, for the public good, should be cleared up and set at rest, for measures taken in ignorance may result in the extermination of a most important and valuable fishery.

The herring is placed among the Physostomes, with the salmon, cod, eel, and other fishes, because the air-bladder and stomach are joined by means of an air-tube passing from the one to the other. It belongs to the order of Malacopterous fishes, which have their fins supported by flexible and branched

jointed rays, and are possessed of comb-like gills, with very large gill orifices. The most important family in this order is the Clupeoid, embracing the herring, sprat, whitebait, pilchard, and anchovy, with many more fishes, largely made use of for food.

The herring is exclusively an old-world fish, being confined to the coasts of Britain and Europe, but never found on those of America. It congregates in large shoals, swimming near the surface of the water, and, because of its numbers, has received the specific name of *harengus*, which, according to Artidi, is the latinized form of the German word "häring"—a host. From observations made on its growth, we are disposed to believe that it is found in four conditions; or, in other words, it has four names for its various stages of growth. The fry, which are small, minute fish newly escaped from the egg, retain this name till they reach the second stage, when they measure from five to six inches in length, and are then called maties. While maties, there is a large deposition of fat surrounding the alimentary canal, which is stored up for the use of the individual during the breeding season. While in the matie form, the reproductive organs are but slightly developed, but as they become full herrings, which is the name for the third change, the stored fat becomes absorbed, and by some is thought to assist in the development of the ova, which, in the full herring, attains its fullest growth, and is then shed or deposited.

After the performance of this function, the fish is sickly and weak, and is then called a shotten or spent fish. These four, the fry, matie, full, and spent, comprise the changes which the herring undergoes from its escape from the egg till its performance of the reproductive function. While passing through these changes, it moves from deep to shallow water, according to the season of the year and the requirements of nature. The older writers believed that the herring was only a visitant to our shores, coming in great "sculls," or shoals, from the Arctic seas to spawn upon our shallows, and after circumnavigating our islands, journeying back to their icy houses in the northern ocean. Pennant, unable to account for them after they left the spawning-beds, considered they must have returned to the Arctic seas, "in order to recruit themselves after the fatigue of spawning." He never took into account the exertion and labour of a journey due north, nor the difficulty of getting sufficient food in the ice-bound seas around Spitzbergen. We have the testimony of Arctic explorers that the herring is comparatively rare in the north; and, above all, we know that they never leave our seas, but remain in deep water not far from the spawning-beds.

The fry, after leaving the egg, move about on the shallow

spawning-ground till they attain a few inches in size, and then they take to the deep water near the shore, where they find abundance of small crustacea and animalculæ on which they feed and become fat maties. They then change into full herrings, and leave the deep sea, approaching the shore where it is suitable for spawning, and there, in great numbers, one shoal above another, extending for many miles, they begin to shed the spawn, which falls to the bottom, and, being of a sticky nature, clings to the stones, and there remains, unless disturbed by storms or trawls, till the young fry burst the egg. The spent fish then leave the shallow water, and seek rest and food in the deep waters far beyond the reach of the net.

How long the herring takes in passing through these changes, and becoming an adult fish, is not known. Some think two, and others as many as seven years are required.

We are not disposed, for various reasons, to agree with these observers, for we consider that all the time required is not more than one year. When we consider that each shoal of fish affects a certain specified part of the sea, never spawning except on the "family ground," we cannot account for the plenty of one year and the scarcity of the next, except by the theory that they pass from the ova to the adult in one year. If we compare the ages and changes of a herring with those of a salmon, we think that the following estimate of the herring's age will be tolerably exact:—two weeks for the production of the fry from the egg, three months to become a matie, four months to feed and fatten into a full fish, and two months to develope the ova and to shed it, thus making ten months from leaving the egg till it becomes a shotten herring ready to retire into deep water, there to become again a full herring, and thus for years returning to spawn, if it is lucky enough to escape the enemies which are always ready to devour and destroy it.

The enemies of the herring are legion. Codfish, hakes, eels, and porpoises pursue it beneath the waves. Razorbills, gannets, and gulls watch its progress from above, and man, provided with implements, does his utmost to capture and destroy it. Such havoc is made by the fish among the spawn and fry that only one fish in every six thousand eggs comes to maturity; yet, with such a waste, the numbers remain as great as ever, for each full fish deposits about seventy thousand eggs; so that there is every probability, if the fishing is rightly conducted, of plenty continuing to all time.

The fish are said to be sometimes erratic in their tastes, affecting one spawning ground for many years, and then forsaking it. Pennant considered they became dissatisfied with the beds, and thus left them, but the true reason is the illegal

and suicidal means which have been used for their capture, resulting in overfishing of the herring and the destruction of the spawn. When trawling is practised, great damage is done to the spawn, and the net being drawn through a "scull," or shoal of the fish, breaks what is called the "eye" of the fish, or, in other words, scatters the shoal, and frightens them from their usual haunts.

Pennant was wrong in supposing that the one shoal of herring visited various spawning-beds, for every fish-curer knows well that the fish frequenting one loch or bay is different from those spawning ten miles distant. In fact, the fish can be distinguished as Lochfynes or Stornoways with perfect ease, thus proving beyond doubt that they have but a local range, and return to spawn on the same shallows they formerly frequented.

These spawning-beds are well known to the fishers, who often use illegal means to compass the capture of the spawning fish by employing trawl-nets, which, dragged over the mass of spawning and gravid fish, tears up the spawn and entangles great quantities of the fish.

The spawn torn from the bottom is driven by the tide ashore, and, consequently, rendered useless. The trawl compasses the capture of the sickly, weak, and unhealthy fish, and renders them unfit for preservation.

Trawling is made illegal on the west coast of Scotland, yet there are many who risk their property in the pursuit; and as there is both excitement and profit in the work, all the efforts as yet made have been unsuccessful in putting an end to it. The peculiar mode of fishing adopted by the trawlers is as follows:—A net, about one hundred yards in length, with meshes of three-quarters of an inch in size, is supplied with corks on one edge and heavy weights on the other, and this is attached by the extreme ends to two boats, one of which remains stationary over the spawning-bed, while the other describes a circle round it, returning close to the side of its consort. By this act, the net which has sunk to the bottom is dragged round myriads of the spawning fish and enclosed. The net is now raised to the surface, and the fish taken on board, when, with sail and oar, the boat makes for the harbour, there to dispose of the ill-gotten gains for a good round sum, because the first of the market is gained, as the drift-net fishers are not able to get into port till on in the day.

When the trawlers come ashore, large quantities of spawn is found in the boat, and, according to good authority, many tons are cast ashore after the trawl has been in operation. Couch bears testimony to the destruction caused by the trawl, and fears for the ultimate value of our fisheries.

To understand the drift-net fishing, we will, as the night

approaches, slip on board a fishing craft, and spend a night at the sea. As the sun sinks beneath the western hills we leave the shore, our sails are unfurled, and our boat dashes out to sea. The fishers watch for signs of the herring, which are easily noticed, for yonder the gulls and gannets are in plenty, wheeling in the air, and then dashing into the sea, emerging with a *clupea* for supper. The herring are there in plenty, and to that place our course is shaped. As we approach, a faint phosphorescence is noticeable on the waters, caused by the presence of the herring "scull." Here, then, we begin to shoot our nets, which are in lengths of 800 to 2000 yards, having meshes of one inch. The net, as it is passed over the stern of the boat, has small corks along the upper edge, with here and there large bladders, which keep it above the surface, while the lower and under part sinks to a depth of eight yards. When all the net is out, the boat is allowed to drift, with the net attached. When morning breaks the net is hauled in, the fish unmeshed, and then the boat is turned harbourwards, with her cheeping cargo—for the fish emit a sound similar to that—and we arrive just as the sun rises above the eastern hills, gilding with glory the rippling waves. The drift-net allows the fish to entangle themselves—no force is used, and the shoals of fish are not disturbed, for, while the fish are moving about during the night they come against the meshes, and in their efforts to pass on get caught by the gill covers, and are captured. The herring caught in the drift-net are all healthy, lively herring, because only these swim near the surface. They are, therefore, "halesome faring," while those taken by the trawl are unfit for human food.

Herring can be caught by means of bait, and they often rise to an artificial fly; but the formation of their gills, and the tenderness of their mouth, renders their capture difficult.

We have made mention of the fish leaving some spawning-beds, and staying away for many seasons. The fisher thinks they are scared by noise; and in Scotland, in olden times, no cannon was allowed to be fired during the time of spawning. It is said that the herring forsook the Baltic after the battle of Copenhagen, and are only now returning to their former haunts.

Lately an outcry arose against burning kelp and running steamboats, as the smoke of the one and the noise of the other scared the fish away; but the most wonderful reason given for their disappearance is that mentioned by a Member of Parliament, in 1835, before the House of Commons. He said that the herring had deserted the coasts near the residence of a priest who had signified his intention of taking tithes of fish.

In concluding this brief sketch of the herring and its

history, we cannot forget to draw attention to the recent inquiry made by the Royal Commissioners. Much valuable information has been gained by it concerning this important fishery; and it is to be hoped that the exposure of our ignorance will result in some experiments being made to discover the true answers to such questions as those we have mooted in this paper.

We think that a series of experiments similar to those made upon the salmon would be of great use. We are aware of some who are willing to aid, both with time and money, in conducting such experiments; and, in our opinion, till such is done, the herring will be as great a mystery as the salmon was.

COMETS.

AN ACCOUNT OF ALL THE COMETS WHOSE ORBITS HAVE NOT BEEN CALCULATED.

BY G. F. CHAMBERS.

(*Continued from page* 221, *vol.* v.)

840 [ii.] On December 3 a comet was seen in the E. country.—(Ma-tuoan-lin.)

841 [i.] Before the battle of Fontenay (that is, before June 25), a comet was seen in Sagittarius.—(*Annal. Fuld.*) In July or August a comet was seen near χ Aquarii.—(Ma-tuoan-lin.)

841 [ii.] On December 22 a comet was seen near α Piscis Australis; it passed through Pegasus into the circle of perpetual apparition. On February 9, 842, it had disappeared.—(Gaubil.) It was seen in the W. from January 7 till February 13.—(*Chron. Turon.*)

852. In March—April a comet appeared in Orion.—(Ma-tuoan-lin.)

855. A comet was seen in France for three weeks.—(*Chronicon S. Maxentii.*) Perhaps in the month of August.

857. On September 22 a comet with a tail 3° long was seen in Scorpio.—(Ma-tuoan-lin.)

858. At the time of the death of Pope Benedict III. a comet appeared in the E.; its tail was turned towards the W.—(Ptolemæus Lucensis, *Historia Ecclesiastica,* xvi. 9.) Benedict died on April 8.

864. On May 1 a comet was seen.—(*Chronicon Floriacense.*) On June 21 a comet was seen to come from the E. It was near α and β Arietis, and had a tail 3° long.—(Ma-tuoan-lin.)

866. Comets were seen before the death of Bardas.—(Con-

XUM

stantinus Porphyrogennetus, *Incerti Continuatoris*, iv.) Bardas was killed on April 21.

868. About January 29 a comet was seen for seventeen days. It was under the tail of the Little Bear, and advanced to Triangulum.—(*Annal. Fuld.*) It was seen in China in the sidereal divisions of γ Arietis and α Muscæ.—(Ma-tuoan-lin.)

869. A comet announced the death of Lotharius the Younger.—(Pontanus, *Historia Gelrica*, v.) Lotharius died on August 8. In September a comet was observed near χ, κ, θ, τ, Persei. It went to the N.E.—(Ma-tuoan-lin.)

873. A comet was seen in France for twenty-five days.—(*Chronicon Andegavense.*)

875. The death of the Emperor Louis II. was announced by a burning star like a torch, which showed itself on June 7 in the N. It was seen from June 6 in the N.E. at the first hour of the night. It was more brilliant than comets usually are, and had a fine tail. This bright comet, with its long tail, was seen morning and evening during the whole of June.—(*Breve Chronicon Andreæ.*) After harmonizing some discrepancies of dates, Pingré says, "The comet would have appeared on June 3 in Aries; having but little latitude, it would consequently have risen a little after midnight, and would have been seen that same night. The following days, as its longitude diminished, and its north latitude increased, it would have been seen by June 6 or June 7, in the evening, towards the N.E.—(*Comèt.* i. 349.)

877. "In the second year of the entrance of Charles the Bald into Italy a comet was seen in the month of March in the W. and in the constellation Libra. It lasted for fifteen days, but was less bright than the preceding one [that of 875]. In the same year the Emperor Charles died."—(*Chronicon Novaliciense.*) Being in Libra, it was in opposition to the Sun, and was therefore visible all night; in the evening in the E. and in the morning in the W.—(Pingrè *Comèt.* i. 350.) Ma-tuoan-lin says that it appeared in the fifth Moon, or in June—July.

882. On January 18, at the first hour of the night, a comet with a prodigiously long tail was seen.—(*Annal. Fuld.*)

885. A comet was seen between α or π Persei and κ Geminorum.—(Ma-tuoan-lin.)

886. On June 13 a comet was seen in the sidereal divisions of μ^2 Scorpii and γ Sagittarii. It traversed Ursa Major and Boötis, near o and π.—(Ma-tuoan-lin.)

891. On May 12 a comet with a tail 100° long appeared near the feet of Ursa Major; it went towards the E. It passed by α Boötis, and went into the vicinity of β Leonis. On July 5 it had disappeared.—(Ma-tuoan-lin; J. Asserius. *Annales.*)

892 [i.] A comet appeared this year in the tail of Scorpio. It lasted four weeks, and was followed by an extreme drought in April and May.—(*Chron. Andegav.*) In June a comet with a tail 2° long appeared.—(Ma-tuoan-lin.)

892 [ii.] In November—December a comet appeared in the sidereal divisions of ϕ Sagittarii and β Capricorni.—(Ma-tuoan-lin.)

892. [iii.] On December 28 a comet appeared in the S.W. On December 31, the sky being cloudy, it was not seen.—(Ma-tuoan-lin.) This may be identical with the preceding.

893. After several months of very bad weather, the clouds went away, and on May 6 a comet was seen near ι and κ Ursæ Majoris, with a tail 100° long. It went towards the E., entered the region lying around β Leonis, and traversed Boötis near Arcturus, passing the region around α Herculis. It was visible for six weeks, and its length gradually increased to 200°. The clouds then hid it.—(Ma-tuoan-lin.) The length is incredible, though Gaubil gives the same.

894. In February—March a comet was seen in Gemini.—(Ma-tuoan-lin.)

LITERARY NOTICES.

On the Structure of the so-called Apolar, Unipolar, and Tripolar Nerve Cells of the Frog. By Lionel S. Beale, F.R.S. etc., etc. *Trans. Royal Soc.*, xxvi.

On Deficiency of Vital Power in Disease. By Lionel S. Beale, M.D., F.R.S., etc. (Richards).

First Principles. *Ibid.*

Archives of Medicine, Edited by Lionel S. Beale, vol. iv. (Churchill).

The first of these publications would alone secure for Dr. Beale a foremost place amongst physiological microscopists. The plates are beautiful illustrations of a series of investigations truly wonderful for the care and skill with which they have been carried out. They are as much an honour to the microscopical science of our country, as they are proofs of the highest order of talent for this class of research. We made a slight mention of this paper in our number for Sept. 1863, p. 148, and we now present the reader with a summary of the most important of its author's conclusions:—

"1. That in all cases nerve cells are connected with nerve fibres, and that a cell probably influences only the fibres with which it is structurally continuous. 2. That *apolar* and *unipolar* nerve cells do not exist; but that all nerve cells have at least two fibres in connection with them. 3. That in certain ganglia of the frog there are large pear-shaped nerve cells, from the lower part of which two fibres proved a *straight fibre* continuous with the central part of the

body of the cell, and a *fibre* or *fibres* continuous with the circumferential part of the cell, which is coiled *spirally* round the straight fibre. 4. These two fibres often lying very near to, and in some cases, when the spiral is very lax, nearly parallel with each other, at length pass towards the periphery in opposite directions. 5. Ganglion cells exhibit different characters, according to their age. In the youngest cells neither of the fibres exhibit a spiral arrangement: in fully formed cells there is a considerable extent of spiral fibre; but in old cells the number of coils is much greater. 6. These ganglion cells may be formed in three ways, *a*, from a granular mass, like that which forms the early condition of all structures; *b*, by the division or splitting up of a mass like a single ganglion cell, but before the mass has assumed the complete and perfect form; *c*, by changes occurring in what appears to be the nucleus of a nerve fibre . . . . 8. There are nuclei in the body of the cell. . . . . 9. The matter of which the nucleus is composed has been termed by me *germinal matter*. From it alone growth takes place. . . . . 10. The nucleolus consists of germinal matter. . . . . 15. As nerve fibres grow old, the soluble matters are absorbed, leaving a fibrous material which is known as connective tissue, and corresponding change is observed in other textures both in health and disease."

We are very glad that the two lectures called "First Principles," and "On Deficiency of Vital Power," have been published in a cheap pamphlet form, because, whatever doubt may attach to certain portions of Dr. Beale's speculations, the facts which he adduces and very much of his reasoning appear to us essential to the right understanding of many highly important problems. Instead of vaguely telling his pupils that irritation excites inflammation, he shows that in a normal state what he terms "germinal matter," in living cells, receives and converts a regulated portion of nutriment from without. By softening the layer of what he terms "formed material," which surrounds the germinal matter, or by tearing through the formed material, an abnormal quantity of pabulum is introduced, and an excessive action of the germinal matter takes place that is not consistent with the health of the organism of which the cells form a part. "The abnormal pus corpuscle is produced from the germinal or living matter of a normal epithetial cell, in consequence of the germinal matter of this cell being supplied with pabulum much more freely than in the normal state."

In the other lecture Dr. Beale lays down the proposition that all living particles have sprung from pre-existing living matter. It cannot be said that we *know* this; but it may be true. "Each separate particle increases, not by particles already existing being applied to it, or coalescing with it, but by the passage of soluble matters into its very substance, and their conversion into matter of the same kind." Arguing logically from the premisses we have extracted, Dr. Beale contends that pus cells, cancer cells, and so forth, exhibit a high, and not a low degree of vital activity.

Disease often differs from health only in the too great activity

with which certain functions are performed, and he shows that alcohol, by hardening the outside layer of cells, diminishes the supply of nutriment that reaches the germinal matter, and thus checks the excess of action that is doing harm.

Having assailed the sham explanations of ordinary physiologists about "diminution of vital force," "irritation," etc., it is curious to find Dr. Beale reverting to the style of argument in which the purgative action of jalap was "explained," by asserting that the drug possessed a "cathartic principle;" and yet this is done in a paper that will be found in the *Archives of Medicine*. Dr. Beale says, "It seems to me probable that the most minute living particle which it is possible to conceive, is a spherule, and this spherule is capable of altering its form. I believe that the alteration results from the influence of wonderful inferent powers, of the nature of which we know nothing as yet, which wonderful powers may at least for the present be termed 'vital,' to distinguish them from physical and chemical properties." In another passage Dr. Beale says, "I have endeavoured to show that the power of movement resides in the living particles themselves, and have expressed the opinion that these movements cannot be explained by physics or chemistry." In another paper the whole fabric of modern science, with its conservation and correlation of forces, is assailed to make way for the return of the old metaphysical assumption, "vital force," which Dr. Beale affirms to be something quite distinct from chemical or physical force in any form. He complains that "vital power no longer excites the speculation of the physiologist or the wonder of the profound metaphysician;" but if it has ceased to do, it is simply because men have discovered that "vital force" is a phrase to cover ignorance, not a term denoting a precise thing. There is no *special* mystery in vital force, if it designates the power that is manifested in living beings. All force is equally mysterious. Scientifically we know nothing of the primary cause, origin, or action of any force whatever. We know that a certain force *is*, and we find out a few of its relations of antecedence or consequence, and when we come to the highest actions we know of, those of mind and consciousness, we have not the faintest idea *why* or *how* the Divine Being has linked them, in our case, with what are called vital actions of an organism.

When Dr. Beale states that living particles must possess an "inherent moving power," we do not know what he means. Would they move under any conditions, and in any medium, as they do under particular conditions, and in a particular medium? If not, they are under the influence of surrounding circumstances, and their motions would appear to be, not an inherent faculty, but the result of their acting, and being acted upon, by matter external to themselves. Nothing is gained by assuming that they are governed by vital forces, "of the nature of which we know nothing," to the exclusion of all the forces of which—so far as their manifestations go—we know a little. It is because we admire Dr. Beale's great talent, and appreciate his services, that we urge him not to tumble into the old quagmire of substituting imaginary metaphy-

XUM

sical entities like "vital force," for more scientific methods of explaining what he sees, or for what is often required, a simple confession that the explanation is unknown.

Lessons on Elementary Botany. By Daniel Oliver, F.R.S., F.L.S., Keeper of the Herbarium of the Royal Gardens, Kew, and Professor of Botany in University College, London (Macmillan and Co.).—In noticing the Memoirs of Professor Henslow in a former number, we adverted to his success as a botanical teacher of village children as well as of his Cambridge class. The present work is partly original, and partly founded upon the papers left by Professor Henslow, and it appears to us an invaluable introduction to the study of botanical science. It is very clearly written, and amply illustrated, leading the student on by an admirable method. As the object is to teach botany as a science, and not as a mere art of giving nicknames to vegetables, it will be highly appreciated by the possessors of microscopes, who will learn from it what they are to look for in accessible plants. It cannot be too strongly recommended to students and intelligent families.

A Series of Seven Essays on Universal Science. By Thomas Clark Westfield, F.S.A. (Hardwicke.)—The publication of this book is a mistake. The author should not have attempted a subject so far beyond his powers.

Saxby's Weather System, or Lunar Influence on the Weather. By J. M. Saxby, Esq., R.N. Second Edition (Longmans).—Captain Saxby's main dictum is, "That the moon never seems to cross the earth's equator without there occurring at the same time a palpable and unmistakeable change in the weather. Such changes most commonly are accompanied either by strong winds, gales, sudden frost, sudden thaw, sudden calms, or other certain interruptions of the weather, according to the season." The present volume contains many illustrations which the author considers to prove the truth of this principle, and concludes with numerous predictions for 1864 and 1865.

Homes without Hands. By the Rev. J. G. Wood, M.A., F.L.S. (Longmans).—An interesting family work, published in monthly parts, with numerous and excellent illustrations. It is a good idea to give a popular and entertaining account of the various members of the animal kingdom remarkable for constructing "Homes without Hands," and Mr. Wood's pleasant labours are sure to be welcome in thousands of homes constructed with hands.

Lecture on the Sources of the Nile. By Charles T. Beke, Esq., Phil. D., F.S.A., Manager of London Institution.—This lecture was first delivered at the London Institution on the 20th January, 1864, and has since been repeated elsewhere, but not formally published, though printed by the London Institution Board of Management. Dr. Beke affirms that "Captains Speke and Grant have returned from visiting three sides of Lake Nyanza, leaving wholly unexplored a blank space of 50,000 geographical square miles (larger in extent than the whole of England and Wales) on the

fourth and uphill side of the lake, where the sources of the river have naturally to be looked for."

THE CLASSIFICATION OF THE SCIENCES; to which are added REASONS FOR DISSENTING FROM THE PHILOSOPHY OF M. COMTE. By HERBERT SPENCER, Author of "First Principles," "Social Statics," etc. *Williams and Norgate.*

We cannot divert from our ordinary subjects enough space to do justice to Mr. Spencer's important essay, in which he points out where his philosophy differs from that of Comte, to whom we think he is scarcely just. M. Comte made a serious mistake in attempting to construct a system in which an intelligent First Cause had no place; and when he tried to imagine a kind of theology that would supply the defect, he resorted to speculations of the most unsatisfactory kind. We believe, however, that he has exercised a very beneficial influence over modern thought through the truth and utility of many of his ideas. His classification of the sciences was certainly imperfect; but this was partly occasioned by the fact that there are really no palpable lines of demarcation, one science merging into another at several points. Mr. Spencer's labours supply valuable material for hard, accurate thinking upon this subject; but we do not believe his classification will satisfy many minds. We should, however, be unjust if we did not admit the skill with which he has developed his ideas.

THE PRINCIPLES OF AGRICULTURE. By WILLIAM BLAND, M.R.A.S., Author of "Principles of Construction in Arches, Piers, Buttresses, etc." Second Edition. (*Longmans.*)—Mr. Bland is well known in Kent as an eminent authority upon agricultural questions, and he has also distinguished himself by displaying great mechanical ingenuity in various departments, boat-building among the rest. The first edition of the present work has been long out of print, and the new one, which is somewhat enlarged, and brought down to date, gives the results of experience in a manner that cannot fail to be useful to agriculturists. Mr. Bland's practical knowledge seems to us in advance of his theoretical acquirements; but the reader who gains a large amount of information from his pages, will not be disposed to cavil if, for example, he finds the word "fermentation" used in a manner that is not very clear. It is important to notice Mr. Bland's opinions on landlords and leases. He thinks "the tenant should be allowed full scope to do what he pleases till within the last three years of his lease," and that at the expiration of the lease the landlord should make an allowance for all improvements.

XUM

PROCEEDINGS OF LEARNED SOCIETIES.

GEOLOGICAL SOCIETY.—*April* 27.

Discovery of Fish in Upper Limestone of Permian Formation.—Mr. Kirkby communicated an account of the discovery of fish remains in the upper limestone of the Permian formation. The strata were exposed in some quarries; the bed from which the fish remains were chiefly obtained was that which is known as the "Flexible Limestone."

The author stated that at least nine-tenths of the specimens belong to *Palæoniscus varians*, the remainder belonging to two or three species of the same genus, and to a species of *Acrolepis*. Detailed descriptions of the different species of fish were given, as also were short notices of the species of plants sometimes found associated with them, one of which he believed to be *Calamites aranaceus*, a Triassic species. The occurrence of *Palæonisci* with smooth scales was stated to be antagonistic to Agassiz's conclusion that the Permian species of that genus have striated, and the Coal-measure species smooth scales. Mr. Kirkby remarked that the fauna of the period appeared to be of an Estuarine character, and he expressed his opinion that the fishes were imbedded suddenly, as a result of some general catastrophe.

The Fossil Corals of the West Indian Islands. By Mr. P. Martin Duncan.—The results of the process of fossilization, as seen in the West Indian fossil corals, is very remarkable, and has much obscured their specific characters, rendering their determination extremely difficult. Hence it is desirable thoroughly to examine their different varieties of mineralization, and to compare their present condition with the different stages in the decay and fossilization of recent corals as now seen in progress. Thus the author was enabled to show the connection between the destruction of the minuter structures of the coral by decomposition, and certain forms of fossilization in which those structures are imperfectly preserved; and he likewise stated that the filling up of the interspaces by granular carbonate of lime and other substances, as well as the induration of certain species, during a "pre-fossil" and "post-mortem" period, gave rise to certain varieties of fossilization, and that the results of those operations were perpetuated in a fossil state.

The forms of mineralization described by Dr. Duncan are—Calcareous, Siliceous, Siliceous and Crystalline, Siliceous and Destructive, Siliceous Casts, Calcareo-siliceous, Calcareo-siliceous and Destructive, and Calcareo-siliceous Casts.

In describing these forms especial reference was made to those in which the structures were more or less destroyed during the replacement by silica of the carbonate of lime of the coral.

In explaining the nature and mode of formation of the large casts of calices from Antigua, the author drew attention to the fact that the silicification is more intense on the surface and in the centre of the corallum than in the intermediate region; and, when

examined microscopically, it could be seen that the replacement of the carbonate of lime began by the silica appearing as minute points in the centre of the interspaces and of the sclerenchyma, and not on their surface. In conclusion, the influence of all the forms enumerated above in the preservation of organisms was discussed, and the relation of hydrated silica to destructive forms of fossilization was pointed out as being one cause of the incompleteness of the geological record.

May 11.

Mammalian Remains near Thame.—Mr. Codrington described a railway-cutting through a hill between Oxford and Thame which exposed a section of certain gravel-beds, from which many Mammalian remains were collected. The hill is nearly surrounded by the Thame and two small tributaries, and consists of Kimmeridge clay capped by a bed of coarse gravel overlain by sandy clay. The gravel consists of chalk-flints, pebbles derived from the Lower Greensand, and fragments of mica-schist, etc., indicating a northern-drift origin; it contained many bones of Elephant, Rhinoceros, Horse, Ox, and Deer, and a single phalanx of a small carnivore, but no flint implements were discovered.

Deposit at Stroud containing Flint Implements, Land and Freshwater Shells, etc.—In the construction of a reservoir near the summit of the hill above the town of Stroud, Mr. E. Witchell observed, about two feet from the surface, a deposit of tufa containing land-shells with a few freshwater bivalves; in it he subsequently discovered several flint flakes of a primitive type, and in the overlying earth a few pieces of rude pottery. The deposit is situated on the spur of a hill nearly separated from the surrounding country by deep valleys; Mr. Witchell considered it to be comparatively recent, and concluded that it had been formed in a pond or lake, which had been caused by a landslip from the higher ground, producing a dam that stopped the downflow into the valley of the water of the neighbouring springs.

ROYAL INSTITUTION.—*May* 6.

The Properties of the New Metal Indium.—Professor Roscoe gave a lecture on the characters of this metal, which has recently been discovered by Reisch and Richter in the Zinc blende of Freiberg, by means of the spectroscope. Indium is distinguished by having a spectrum consisting of two bright indigo-coloured lines, and by its compounds tinting the colourless flame of a Bunsen burner of a violet colour.

Hitherto indium has only been obtained in very minute quantity from the Freiberg blende, consequently its properties and compounds have not been very carefully examined. It appears closely to resemble zinc, with which it has hitherto always been found in combination. It is, however, a softer metal, marking paper like lead; it is readily soluble in hydrochloric acid, and, heated in the

XUM

open air, it oxidizes freely, yielding a white oxide easily reducible before the deoxidizing flame of the blow-pipe.

The hydrated oxide is precipitated from its salts by potash and ammonia, but is insoluble in excess of either of these re-agents; hence it is easily distinguished from both zinc and alumina.

The oxide may be separated from oxide of iron, with which it is associated in the zinc blende by precipitating the latter with bicarbonate of soda. The precipitated sulphide is insoluble in alkalies. The quantity of indium salts exhibited by Professor Roscoe consisted of about three grains; with these he succeeded in demonstrating its properties, and exhibited the characteristic indigo spectrum in a very striking manner.

Professor Roscoe also alluded to the new discoveries made with the spectroscope. Cesium and rubidium have been found to exist in many articles of human consumption, such as beet-root sugar, tea and coffee. Thallium has been found in many minerals in which its presence was hitherto unsuspected, and to occur also in very appreciable quantity in molasses, the yeast of wine, chicory, and even in tobacco.

A new and comparatively abundant source of these three rare metals, cesium, rubidium, and thallium, has been discovered; the water of a spring near Frankfort leaves on evaporation a saline residue which contains the three metals in appreciable quantity.

Recently a more attentive examination of the rays emitted by the sun's photosphere has been made, and it is found that it exhibits no trace of potassium salts. Hence that element may be regarded as being absent from the solar atmosphere.

The spectrum of burning magnesium has been found to be particularly rich in chemical rays, and has consequently been used with success as a photographic light. Professor Roscoe stated that if the surface of burning magnesium has an apparent magnitude equal to that of the sun seen from a certain point, the chemical action effected by the magnesium on that point is equal to that produced by the sun when at an elevation of 9° 53′. And that at a zenith distance of 67° 22′ the visible brightness of the sun's rays is 524·7 times that of burning magnesium, whilst its chemical brightness is only 36·6 times as great as that of the burning metal; hence the great use of the latter in photography. A thin magnesium wire produces in burning as much light as seventy-four stearine candles, and to continue this light for ten hours, seventy-two grammes—about two ounces and a half—of magnesium must be burnt, corresponding in effect to twenty pounds of stearine candles. A magnesium lamp was exhibited, consisting of a coil of magnesium wire, which was gradually unwound and burnt as it issued from a glass tube. Magnesium wire of a size convenient for burning is now manufactured by Mr. Sonstadt's process, and sold at threepence per foot; the combustion of one inch of wire affording sufficient light to take a positive picture with dry collodion. During the lecture a negative of Professor Faraday was taken; from this a transparent positive was printed by a few seconds exposure, and exhibited on the white screen by the electric lamp.

ROYAL GEOGRAPHICAL SOCIETY.—*May* 9.

A NEWLY-DISCOVERED LOW PASS OVER THE ANDES IN CHILI, SOUTH OF VALDIVIA.—Sir Woodbine Parish stated that Señor Cox had undertaken this remarkable journey with a view to discover an easy route between the new Chilian settlements on the Pacific coast in 40° and 41° S. lat. and the river Negro, which, eighty years ago, had been proved by Villarino, a Spanish explorer, to be navigable from the eastern side of the Andes to the Atlantic. He equipped an expedition at his own cost at Port Montt, a new German settlement, now containing 15,000 inhabitants, near the island of Chiloe, and proceeded in December, 1862, by way of the two lakes, Llanquilhue and Todos-os-Santos, towards the almost unknown inland sea of Naguel-huassi. He traversed the lakes by means of gutta-percha boats, and succeeded in discovering a pass over the Cordillera at an altitude of not more than 2800 feet. Arrived at the end of Lake Naguel-huassi (Lake of Tigers), which lies on the eastern side of the chain of the Andes, Señor Cox's party found a broad stream issuing from it in the direction of the rivers which flow into the Atlantic. Seven of the sixteen persons who formed the expedition embarked in one of the boats and descended the river, which is called the Limay, and forms one of the affluents of the Rio Negro. The voyage was attended with great risks, owing to the numerous rapids. At length when within five miles of the point to which Villarino had attained in ascending the Rio Negro from the Atlantic, the boat was upset, and the party fell into the hands of a savage tribe of Pampas Indians encamped near the spot. The Cacique at length promised to assist Señor Cox in reaching the Rio Negro on condition that he first went to Valdivia for presents. The re-crossing of the Cordillera, at a more northerly point, towards Valdivia, was accomplished without much difficulty: but the main object of Señor Cox's journey, namely, the opening of an easy passage across the Continent has been up to the present time frustrated by the hostility of the Indian tribes.

NOTES AND MEMORANDA.

THE SURFACE OF THE SUN.—Notwithstanding the statements of the Greenwich astronomers, the question of the rice grains or willow leaves on the solar surface is not considered to be settled. Mr. Wm. Huggins, who is an excellent observer, and possesses a fine telescope, denies that the solar surface consists of an interlacement of elongated particles, definite in shape, and uniform in size. He finds the brighter portions of every imaginable shape, and greatly differing in size. It certainly seems highly improbable that the monotony and uniformity of willow leaves or rice grains should be preserved in the face of a body that is proved by the behaviour of the spots to undergo violent changes. From the *Monthly Notices* of the Astronomical Society (1864, No. 6), it will be seen that Mr. Dawes, who is universally admitted to be one of our finest observers, affirms that "the observations of Messrs. Stone and Dunkin have landed them precisely where he was sixteen years ago." At that time he compared the bright particles scattered almost all over the sun to excessively minute fragments of porcelain; but he doubted the appearance, and after four years more research, and the

assistance of his own solar eye-piece, which permitted the use of a power of 400 to 600, he arrived at the conviction that the "brilliant objects were merely different conditions of the surface of the comparatively large luminous clouds themselves, ridges, waves, hills, knolls, or whatever else they might be called, differing in form, in brilliancy, and probably in elevation, and bearing something of the same proportion to the individual luminous clouds that the masses of the bright faculæ, as seen near the sun's edge, bear to the whole disc of the sun."

THE COMPANIONS OF SIRIUS, TRUE AND FALSE.—Mr. Dawes states, in *Monthly Notices*, that he has attained with his $8\frac{1}{2}$-inch object-glass distinct views of Alvon Clark's Companion of Sirius. Angle of position, 84°·86, distance about 10″. Mr. Lassell and Mr. Marth have also observed it at Malta, their measures of position ranged from 78°·53 to 80°·29, and their distances from 9″·21 to 10″·90. The little star appeared not a very small point, but deficient in brilliancy to Mr. Lassell, and when Mr. Dawes first saw it, he turned round his object-glass and eye-pieces to be certain it was a real star. His measures were only approximate. Mr. Tempel, of Marseilles, has a letter in the *Astron. Nachrichten*, detailing his efforts to see the companions observed by M. Goldschmidt with a telescope of about 4-inches. Mr. Tempel employed one of 48 lines, which he says is a little bigger than M. Goldschmidt's, and of excellent performance on double stars. With this instrument, after many hours' observation, he saw three companion stars with magnifications of 40 and 24. He saw them less plainly with 60, and not at all with 80 and upwards. He saw similar appearances near Procyon, Capella, and β Orionis; in the latter case, in addition to the true companion. Careful experiment satisfied him that the appearances were false, and that Goldschmidt had been deceived in assigning additional companions to Sirius.

SIZE AND FIGURE OF THE EARTH.—The results obtained by our Ordnance Survey exhibit the earth as having an equatorial semi-diameter of 20,927,005 feet, and a polar semi-axis of 20,852,372 feet. The flattening being $\frac{1}{280{,}4 \pm 8{\cdot}3}$

Comparing arcs of the meridian measured in England, France, Russia, Prussia, Hanover, Denmark, and India, the Ordnance Survey gives for the average of the globe—

Semi-equatorial diameter, 20,926,330 feet.
Semi-polar axis . . . 20,855,240 feet.
Flattening . . . . . $\frac{1}{294{,}36}$

The latter calculations take in the final determinations of the great Russian arc measured by M. Struve. The French metre is thus not, as was supposed, exactly a ten-millionth part of any ascertained quarter of a meridian, nor of an average quarter meridian.

SILKWORMS OF THE OAK.—M. Guerin Méneville informs the French Academy that, in addition to three Asiatic silkworms living on the oak, the *Bombyx melitta* from Bengal, and *Bombyx Pernii* from N. China, and *Bombyx Yama-Maï* from Japan, he is trying to naturalize a fourth, the *Bombyx Roylei*, from the Himalayas, on the borders of Cashmere. On the 23rd March he received 20 cocoons. At first only males were produced, but on the 19th April he obtained a male and female moth, the latter laying 108 eggs. M. Méneville thinks it will be easy to rear these silkworms in Central and Northern France.

FUNCTIONS OF THE CEREBELLUM.—Dr. Dickinson states that experiments with reptiles and fish show that the cerebrum by itself is unable to give more than a limited amount of voluntary motion, and that of a kind deficient in balance and adjustment. If the cerebellum only be removed from fishes, there is a loss of the proper adjustment between the right and left sides, so that oscillation or rotation takes place. All the limbs are used, but apparently with a deficiency of sustained activity. From the negative results of experiments it is inferred that the cerebellum has nothing to do with common sensation, with the sexual propensity, with the action of the involuntary muscles, with the maintenance of animal heat, or with secretion. The voluntary muscles are under a double influence, from the cerebrum and the cerebellum. The anterior limbs are

chiefly under the influence of the cerebrum; the posterior of the cerebellum. Cerebellar movements are apt to be habitual, while cerebral are impulsive. The cerebellum acts when the cerebrum is removed, though when both organs exist it is under its control.—*Proc. Roy. Soc., No.* 63.

Toning Bath for Albumen Process.—In reply to one of our correspondents, who has requested us to give a good formula for a *toning bath*, we select the following out of a great number at present in use, as, in ordinary circumstances, among the most convenient and effective. Place one litre of distilled water, and then two grammes of chloride of gold in No. 1—a bottle with a cork: one litre of distilled water, and then twenty grammes chloride of lime in No. 2—a bottle with a ground-glass stopper: one litre of distilled water, and then five grammes of common salt, in No. 3—a bottle with a cork. All the chloride of lime will not be dissolved; but what remains at the bottom of the bottle will keep the fluid saturated, which is necessary:—before being used the required quantity of it must be filtered. The toning bath is made as follows:—To one litre of distilled water is added 60cc of the fluid in bottle No. 1, 20cc of that in No. 2, and 15cc of that in No. 3. The mixture should be limpid, and either colourless or of a light yellow tinge. It must be used at once, as it will not keep. According to the time during which the proofs are immersed in it, the shade will vary from some tint of blue to a deep black: a dark violet being produced in moderate weather in about twenty minutes—in cold weather a longer time will be required. The whites will be beautifully bleached by the free chlorine. A litre of this mixture will tone about 70 cartes de visite. They must be moved about in it, and occasionally taken out, and replaced. The quantity required for any number of proofs of any size may be easily calculated.

Earthquake in Sussex.—On the 30th April a shock was felt in several places in Sussex, Lewes included. The strongest effect is reported to have been felt at Chailey. A lady at Lewes heard a noise like hail shortly after midnight (31st). At Fletching the people supposed a gunpowder explosion had occurred.

Conical Hail.—M. J. A. Barral describes to the French Academy some hailstones that fell in Paris on the 29th March, 1864. They were of conical shape, slightly concave at the base, and fell point downwards. The cones were eight or ten millimètres in diameter at the base, and ten to thirteen millimètres high. They seemed to be formed by the adhesion of small pyramids, leaving a little hollow inside.

Great Crocodile of the Oolite.—M. A. Valenciennes exhibited to the French Academy on the 11th April a fossil crocodile tooth found in the Oolite, near Poitiers. From its size he estimated the animal to have been one hundred feet long. This creature must not be confounded with the megalosaurus.

Comparing the Light of Stars.—In *Comptes Rendus* for the 11th April M. Chacornac describes a method of mounting a plane mirror so as to bring into the field of a telescope the image of one star, while the telescope receives directly the light of another. By this means the two images are brought into simultaneous view, the one of course less brilliant than it should be, through loss of light in reflection. He gives the calculations necessary to work out the comparison. Sirius he finds to be five times as bright as Arcturus. He is able to work by this method upon stars from 20° to 160° apart. When seen simultaneously, Arcturus looks orange red, and Sirius has a slight green tint.

The Moth of the Ordeal Bean—Insensibility to Poison.—Dr. Fraser shows in the *Annals of Natural History* that the caterpillar of *Deiopeia pulchella* can eat the poisonous ordeal bean of Calabar with impunity, and is in the habit of boring holes in it. This caterpillar is readily killed with hydrocyanic acid, while the *Anthonomas druparum* can live upon the kernel of the Prunus cerasus that contains it.

Grafting Animals.—Dr. Paul Bert has published a work on the curious subject of animal grafts. He succeeded in making Siamese twins of a couple of rats, and in many other monstrosities. He exclaims, "it is a surprising spectacle to see a paw cut from one rat live, grow, finish its ossification, and regenerate its

nerves, under the skin of another, and when we plant a plume of feathers under the skin of a dog, what a miracle to see the interrupted vital phenomena resume their course, and the fragment of a bird receive nourishment from the blood of a mammal."

Formation of Thick Ice.—M. Lucien de la Rive has recently read an elaborate paper on the Conductibility of Heat by Ice, before the Societé le Physique and d'Histoire Naturelle de Genève, which is reprinted in the *Archives des Sciences*. In this essay he enters, amongst other things, on the time required to form thick masses of polar ice by gradual freezing of the water touching their lower surfaces. One metre in thickness would, he states, require 1·42 years, 10 metres 142 years, 100 metres, 14,200 years, 200 metres, 56,800 years. The huge masses seen by Scoresby and others, having a probable thickness of 200 metres, may have grown by snow falling on their upper surfaces; but if it were possible to determine by difference of structure what portion resulted from this cause, and what was produced by additions from below, the time consumed in the formation of the latter might be computed according to the formulæ which M. de la Rive gives.

Viewing Tadpole Circulation.—Those who are not familiar with the best arrangements for this purpose should consult Mrs. Ward's excellent *Microscope Teachings*. All but the very youngest tadpoles are too thick for the live box; older ones may be placed, as in Mrs. Ward's sketch, on a slide, and partly covered with a little tuft of wet cotton wool. They will generally be quiet enough without tying down. When the gill circulation is to be viewed, the cotton should be placed over the tail, and when the gills have disappeared, and the tail circulation becomes a beautiful spectacle, the cotton should be placed over the creature's head and body.

Cure for Hooping Cough.—The *Courier du Pas du Calais* mentions several instances of the cure of hooping cough by inhalation of the vapours evolved by the lime used in purifying coal-gas. It affirms that two or three visits to the gas-works have usually proved sufficient.

Mr. Glaisher's 18th Ascent took place on the 6th of April, at 4·7 p.m., from Woolwich Arsenal. The sky was overcast at starting, and had been so all day, wind S.E. The balloon crossed the river into Essex; at 500 feet elevation the air was very misty, and increased in density as the balloon rose; at 2000 feet wind was SW. or WSW.; at 2500 feet dense white cloud; at 3500 feet thin rain; at 4000 feet clouds less dense, and increase of light; at 4500 feet sun seen faintly; at 5100 feet the sun cast a faint shadow, but cloud continued up to 6500 feet; the air was still misty, and after reaching 8100 feet mist increased till the height of 9000 feet; at 9500 feet bright sunshine, and it was quite warm. At 10,000 feet Mr. Glaisher says, "We were quite out of the cloud, and there was a sea of white cloud, dazzling in its brightness, extending without break or irregularity in its surface as far as we could see all around, that is, for more than 100 miles on all sides; near to us on the cloud on the side opposite the sun was a bright oval halo of immense extent, in the centre of which was situated the shadow of the balloon and car, but without prismatic colours. This all appeared to revolve with us, for it was constant, and we knew we were turning round by the sun now shining on our backs and then in our faces. At the greatest elevation, 11,000 feet, there was perfect repose, the sky was without a cloud, of a beautiful deep blue." The temperature on leaving was 46°; at 1000 feet, 41½°; at 1500 feet, 40°; at 2000 feet, 37°; at 3000 feet, 32°; from 3500 to 4000 feet, no variation from 33°; at 5000 feet temperature rose to 36°; at 8000 feet, 40°; at 9000 feet, 34°; between 10,000 and 11,000 feet, 46°. In descending, the highest temperature was at 8000 feet, 46°, at that elevation it is usually 30° to 40° lower than on the earth. Within two miles of the earth totally opposite currents were found. No ozone was detected.